R-3825-3
VOLUME II

TECHNICAL MANUAL

MAINTENANCE AND REPAIR

J-2 ROCKET ENGINE

(ROCKETDYNE)

CHANGE NOTICE

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Insert changed pages into basic publication. Destroy superseded pages.

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LIST OF EFFECTIVE PAGES

NOTE The portion of the text affected by the changes is indicated by a vertical line in the outer margin of the page

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 208 **CONSISTING OF THE FOLLOWING:**

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A-4	1	15 Mar 75						

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This page reflects the current status of the complete manual. All pages listed must be in the manual to make this publication current and complete.

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INTRODUCTION

This manual is one of the R-3825-series technical manuals prepared to provide official Rocketdyne field support documentation for the operation and maintenance of the J-2 Rocket Engine, Part Number 103826, Serial Numbers J-2046, J-2056, J-2062, J-2083, J-2087, J-2095, J-2103, J-2104, J-2107, J-2126 through J-2130, J-2132, J-2135 through J-2147, and J-2149 through J-2152, and its related ground support equipment, designed and manufactured by Rocketdyne, a division of North American Rockwell Corporation, 6633 Canoga Avenue, Canoga Park, California 91304. The information in these manuals was prepared by Logistics Product Support Department of Rocketdyne.

The manuals are used to best advantage when each manual is current and complete (see figure 1) and the purpose and scope of each manual is known. The manuals in this series, and the nature of the data each provides, are found in the contents and support function chart.

1. J-2 MANUALS--THEIR SUPPORT FUNCTIONS.

The contents and support function chart lists all J-2 series technical manuals, describes the support function of each manual, and lists the section titles of each manual. The chart also explains how the technical data in each manual relates to the support of the engine and its ground support equipment throughout a normal engine flow, as well as during unscheduled maintenance tasks. Information appearing in one manual is not duplicated in another. Thus, information on the description, operation, and maintenance of ground support equipment is in R-3825-5. However, the instructions for servicing the engine using ground support equipment are in R-3825-3 and R-3825-1B.

Manual	Contents and Support Function	Section and Title
R-3825-1 J-2 Rocket Engine Data	This manual contains a description and theory of operation of the engine, its systems, and its components; mass properties and design load criteria, including engine weight, gimbaled mass, center of gravity, and moment of inertia for the basic engine and its accessories; and customer connections.	I Description and Operation II Deleted through VII VIII Performance IX Mass Properties and Design Load Criteria X Electrical System Interface Data XI Instrumentation System Interface Data XII Customer Connections
R-3825-1B J-2 Rocket Engine Operating Instructions Supplement	This manual contains authorized field operating requirements that affect flight engines during their normal flow from engine receipt through vehicle launch, and those procedures recommended by Rocketdyne that support these requirements most effectively. All specific and general requirements for activities to be performed and acceptability criteria for these activities are included along with the limits, special constraints, safety precautions, and correct sequences required to satisfactorily accomplish the activities.	I Operating Requirements II General Requirements III Operating Procedures

Manual	Contents and Support Function	Section and Title
R-3825-3, Volume I J-2 Rocket Engine Maintenance and Repair	This manual contains requirements and procedures for handling; component removal and installation; cleaning; post-maintenance test requirements; the safety precautions to be observed; and information on the tools, materials, electrical power, and pressurizing agents necessary to perform the tasks.	I General Maintenance and Repair II Handling III Component Removal and Installation IV Post-Maintenance Test Requirements V Preparation of Components Handler Equipment for Use VI In-Place Tube Welding
R-3825-3, Volume II J-2 Rocket Engine Maintenance and Repair	This manual contains requirements and procedures for component bench testing and repair; the safety precautions to be observed; and information on the tools, materials, electrical power, and pressurizing agents necessary to perform the tasks.	See table of contents for this manual.
R-3825-4, J-2 Rocket Engine Illustrated Parts Breakdown	This manual contains related illustrations and columnar listings of all parts of the engine that can be replaced at field sites as determined by the maintenance concept; definitions and designations of source, maintenance, repairability, interchangeability, and usable-on codes; information pertaining to retrofit modifications; identification of next-higher assemblies; identification of reference designation numbers.	I Introduction II Group Assembly Parts List III Numerical Index
R-3825-5, Volume I J-? Rocket Engine Ground Support Equipment Maintenance and Repair	This manual contains a description of engine servicing, handling, and test equipment; procedures for performing maintenance and checkout tasks; and inspection and maintenance requirements tables.	I General Information II Thrust Chamber Throat Plug Kit G3120 III Thrust Chamber Protective Pad 9016705 IV Electrical Checkout Console G1037 V Flight Instrumentation Checkout Console G1035 VI Data Recorder Console G3121 VII Engine Test Plates, Adapters, and Tools VIII Extended Range Vibration Safety Cutoff Set G1038 IX Pneumatic Console G3106 X Pneumatic Flow Tester G3104

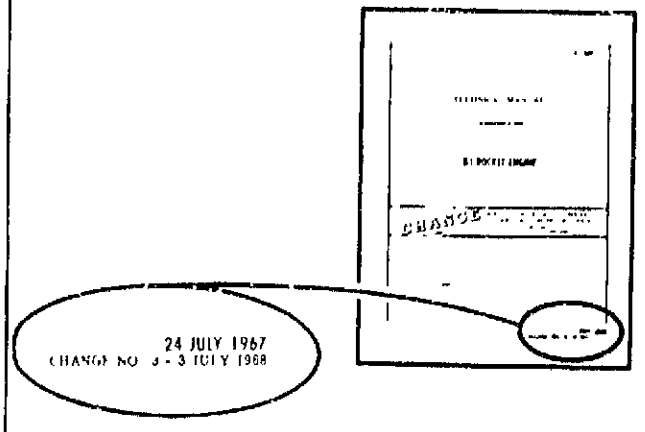
Manual	Contents and Support Function	Section and Title	
R-3825-5, Volume I (cont)		XI	Simulator Panel 9024480-11
		XII	Components Test Console G3107
		XIII	Automatic Inert Gas Arc Welding Set G3128
		XIV	Single Head Special Tool Kit G3127
		XV	Propellant Utilization Valve Voltage Adjust and Monitoring Test Unit 9025664
R-3825-5, Volume II J-2 Rocket Engine Ground Support Equipment Maintenance and Repair	This manual contains a description of engine servicing, handling, and test equipment; procedures for performing maintenance and checkout tasks; and inspection and maintenance requirements tables.	I	General Information
		II	Gas Generator High-Low Temperature Cutoff Panel G1047
		III	Outboard Engine Restrainer G4066
		IV	Film-Cooled Diffuser G4070
		V	Components Adapter Set 9016796
		VI	Liquid Nitrogen Service Unit 2425000
		VII	Electrical Interface Support 9024460
		VIII	Spark Monitor/Overspeed Cutoff Panel G1045
		IX	Component Slings
		X	Spark Monitor Turbine Overspeed Cutoff Test Set 9024499
		XI	Ignition Detector Set 99-9026355
		XII	Components Maintenance Sets/Kits
		XIII	Vibration Safety Cutoff Test Set 9024498
		XIV	Hot-Gas Temperature Transducers NA5-27323T4 and NA5-27342T3
		XV	Amplifier Mounting Panel 9024500
		XVI	Thrust Chamber Diffuser Installing Tool Kit 9025144
		XVII	Proof-Test Weights
		XVIII	Engine Handling Slings
		XIX	Turbopump Sling
		XX	Propellant Inlet Duct Null Adjuster Set 9024540
		XXI	Inlet Duct Support Frame Installing Tool Kit 9025150
		XXII	Engine Handler G4064

Manual	Contents and Support Function	Section and Title
R-3825-5, Volume II (cont)		XXIII Engine Vertical Installer G4035 XXIV Turbopump Maintenance Stands XXV Turbopump Maintenance Sets XXVI Sequence Controller and Oxidizer Heat Exchangers Handlers XXVII Propellant Inlet Duct Handlers XXVIII Propellant Feed System Handlers XXIX Start Tank Installer 9016783 XXX Fluid Lines Interface Support 9020628 and Fluid Lines Interface Arm Support 9026988 XXXI Thrust Chamber Seal Balloon 9016720 XXXII Spark Igniter Cable Pressurization Tool Kit 9025425 XXXIII Engine Components Installers

USE YOUR MANUAL ONLY IF CURRENT AND COMPLETE

Manuals that are not current and complete are not authoritative documents and are not to be used. The following outlines the method for determining whether your manual is current and complete.

A. DETERMINING CURRENCY. To be sure that yours is the latest issue of the manual, refer to Configuration Identification & Status Report , which is revised monthly and lists the technical manual numbers, titles, unincorporated supplements, and latest change or revision dates. Your manual must have a title page with the same or later date than the date shown in the Configuration Identification & Status Report. Your manual must also include the unincorporated supplements listed in the Configuration Identification & Status Report, or if your manual is later than shown in the report, the unincorporated supplements listed in the Manual Data Supplement Record in your manual. If your title page incorporates two dates as illustrated below, compare the change (lower) date. If your manual is not current, obtain a current copy through your technical manual supply system.

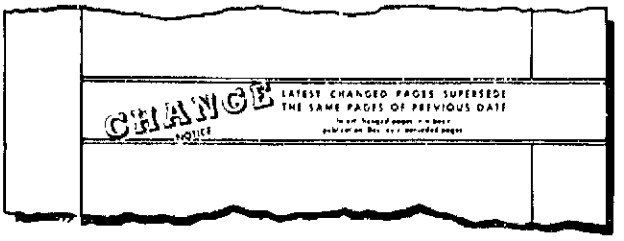


B. DETERMINING COMPLETENESS. To be sure that your manual is complete, make a page-by-page comparison of its pages to those listed in the List of Effective Pages. The List of Effective Pages, which shows the change status since the basic issue or last revision, is found on the alphabetically lettered page(s) immediately following the title page. All pages, except supplements, are listed with their issue dates. Manual pages that are dated must have the same date as that appearing in the List of Effective Pages for that page. Unchanged pages are listed as "original" and are not dated.

HOW TO KEEP YOUR MANUAL UP-TO-DATE

As design changes are made to the rocket engine and ground support equipment and better methods of maintenance are discovered, your manual is periodically changed, revised, or supplemented. The following steps will help you keep your manual up-to-date:

A. CHANGES. Updating by adding to or partially replacing existing pages is defined as a change. Changes can be identified by the change notice on the new title page.



To collate a change, refer to the Filing Instructions sheet issued with the manual and proceed as follows:

1. Remove the pages listed in the "Remove" column of the Filing Instructions sheet from the manual and destroy them. Do not concern yourself with the data on the opposite side of the deleted page since, if this date is not deleted, it is replaced in the change package.

2. Insert all pages listed in the "Insert" column of the Filing Instructions sheet in sequence. Pages with a suffix letter are inserted in alphabetical order following the page with the same basic number; for example, pages 3-14A, 3-14B, etc, follow page 3-14.

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Figure 1. How to Maintain Your Manual (Sheet 1 of 2)

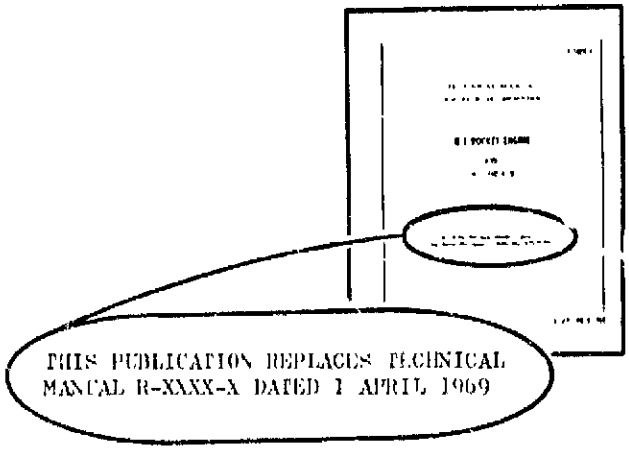
3. If you are unsure of the status of any page or pages, refer to the List of Effective Pages and make sure your manual contains pages (with the corresponding change dates) listed in the List of Effective Pages.

4. Remove manual supplements that have been incorporated.

NOTE

Incorporated supplements can be determined by reviewing the newly issued Manual Data Supplement Record.

B. REVISIONS. Updating by replacing all the existing pages of a manual is defined as a revision. Revisions can be identified by the replacement notice on the new title page.



To collate a revision, proceed as follows:

1. Remove and destroy all existing pages of your manual except Manual Data Supplements that have not been incorporated.

NOTE

Unincorporated supplements can be identified by reviewing the Manual Data Supplement Record supplied in the revision.

2. Insert the new pages in your cover.

C. SUPPLEMENTS. Updating that authorizes the addition to, or alteration of, the existing data in your manual is defined as a Manual Data Supplement. Information on how to insert supplements is found in the supplements.

HOW TO KEEP ABREAST OF THE LATEST CHANGES TO TECHNICAL DATA

Changes and/or additions to technical data are identified by a vertical bar (change bar) in the margin of the page adjacent to the changed data. A direct comparison between the new (identified by the change bar) and the old data will help you in identifying specific changes made.

GEN-NASA-2

Figure 1. How to Maintain Your Manual (Sheet 2 of 2)

2. CONFIGURATION IDENTIFICATION.

Refer to R-3825-3, Volume I, for configuration identification.

3. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

Refer to R-3825-3, Volume I, for a list of approved ECPs (Engineering Change Proposals) and associated MD numbers applicable to components covered in this volume.

SECTION I

AIR FILLER VALVE (PRESSURIZING VALVE)

WARNING

COMPONENTS ADAPTER SET 9016796 AND SPARK IGNITER CABLE PRESSURIZATION TOOL KIT 9025425 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

1.1 SCOPE. This section contains procedures for repairing and testing air filler valves.

1-2. REPAIRING.

1-3. Field level repair of the air filler valve consists of replacing the cap, cap tether, packing, and/or the core.

1-4. REPLACING CAP AND CAP TETHER.

a. Obtain crimping tool No. 17-1 (National Telephone Supply Co) and a 3/16-inch drill or their equivalents. (The drill is not mandatory, but will help in performing this task.)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove cap tether by cutting wire rope or chain loose from cap retaining groove.

d. Clean (paragraph 1-5) cap to be used.

e. Install new wire rope in retaining groove on existing or new cap and install sleeve by crimping with crimping tool. (See figure 1-1.) Make sure loop around cap is free to swivel but will not come off.

f. Make a second open loop as shown in figure 1-1. (Drill shank may be used to hold loop inside diameter while crimping sleeve.)

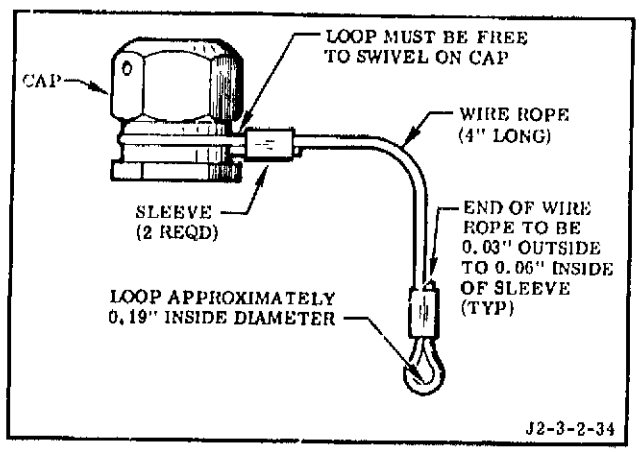


Figure 1-1. Cap and Cap Tether

1-5. CLEANING.

a. Obtain the following equipment and materials, or their equivalent.

(1) Ultrasonic cleaner, Model D-50 (Sonogen).

(2) 10X (minimum) magnifier 81-61-71 (Bausch and Lomb).

(3) 250 ml glass beaker 8845-72 (Cole Parmer).

(4) Forceps 30054 (Van Waters and Rogers).

(5) Soft nylon bristle toothbrush. (Required only when cleaning core.)

(6) Clean nylon cloths.

(7) Cleaning compound (MIL-C-81302).

(8) Air-circulating oven capable of 180° to 220° F or gaseous nitrogen for drying cleaned parts.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

CAUTION

Swivel nuts or stems must not be interchanged from valve to valve. Swivel nut and stem must be retained as a unit.

c. Remove visible contamination by flushing cap, swivel nut, and stem with cleaning compound (MIL-C-81302) and/or handwiping and brushing with clean nylon cloth and toothbrush dampened in cleaning compound (MIL-C-81302).

CAUTION

The core must not be torqued with a wrench calibrated in in-lb, since damage to the core and/or valve can result.

d. Condition threads of new core by threading core into stem and torquing core to 24 ±5 in-oz. If only the core is being cleaned, use a spare stem to condition the threads.

e. Hold new core open (figure 1-2) so that sealing surface is exposed. Clean sealing surface with toothbrush dampened in cleaning compound (MIL-C-81302).

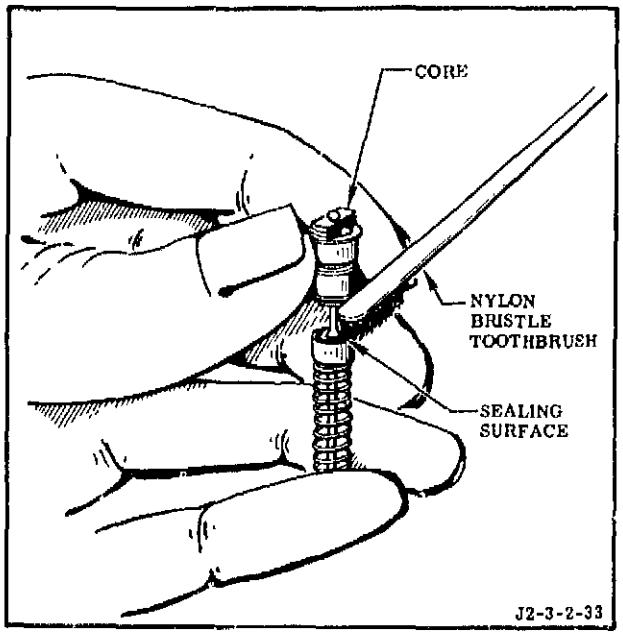


Figure 1-2. Cleaning Core

f. Place cap, swivel nut, stem, and/or new core in clean glass beaker filled with cleaning compound (MIL-C-81302) so that parts are completely covered.

g. Allow parts to soak 5-7 minutes.

h. Suspend beaker in fluid in ultrasonic cleaner.

i. Start generator on ultrasonic cleaner and operate cleaner for 1-5 minutes. Do not start heater; heating of fluid is not required. Using forceps, rotate parts only as necessary to obtain effective cleaning on all surfaces.

j. Remove beaker from ultrasonic cleaner and drain off cleaning compound.

k. Rinse parts in cleaning compound (MIL-C-81302) by agitating totally immersed parts for 1-5 minutes.

l. Pour off cleaning compound.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

m. Dry parts in air-circulating oven at 200° ±20° F or by blowing with low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401).

n. Visually inspect each part for presence of foreign matter such as particles, grease, oil, etc. Hold core open and inspect sealing surfaces for obvious damage and particles using magnifier. Reclean part if foreign matter is present.

CAUTION

Swivel nuts or stems must not be interchanged from valve to valve. Swivel nut and stem must be retained as a unit.

o. If air filler valve will not be assembled immediately, prevent contamination by packaging cap, swivel nut, stem, and/or new core as outlined in R-3825-3, Volume I. Isolate parts with heat seals.

1-6. REPLACING CORE. (Figure 1-3.)

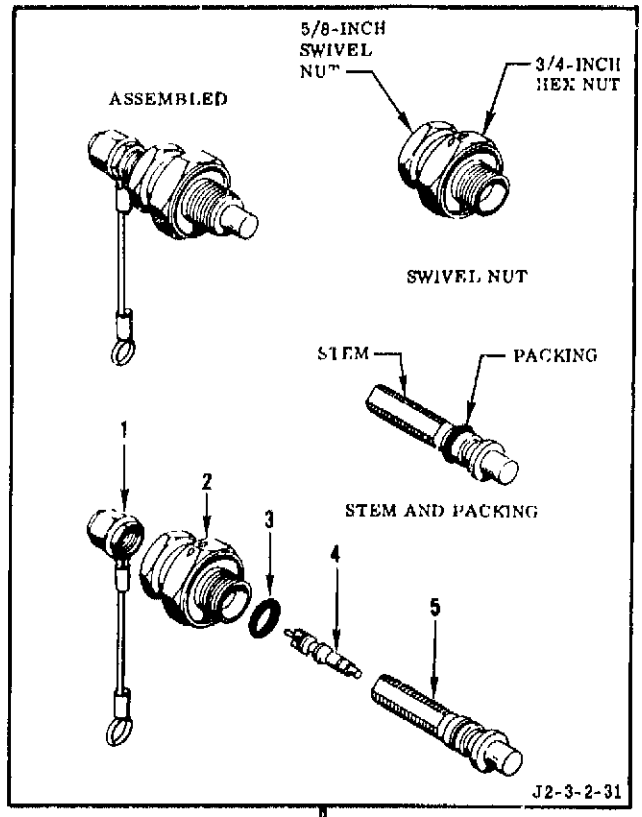
a. Obtain a core removal tool EWR183648-1, or -2, and an in-oz torque wrench capable of applying 19-29 in-oz.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove cap (1).

d. Using core removal tool, remove core (4). Discard core.

e. Measure depth of core well in stem (5). A suggested method, using a drill shank or rod, is shown in figure 1-4. Make sure tool used is clean. Depth must be a minimum of 1-3/8 inches, otherwise replace valve.



Index No.	Description	Index No.	Description
1	Cap	4	Core
2	Swivel nut	5	Stem
3	Packing		

Figure 1-3. Air Filler Valve

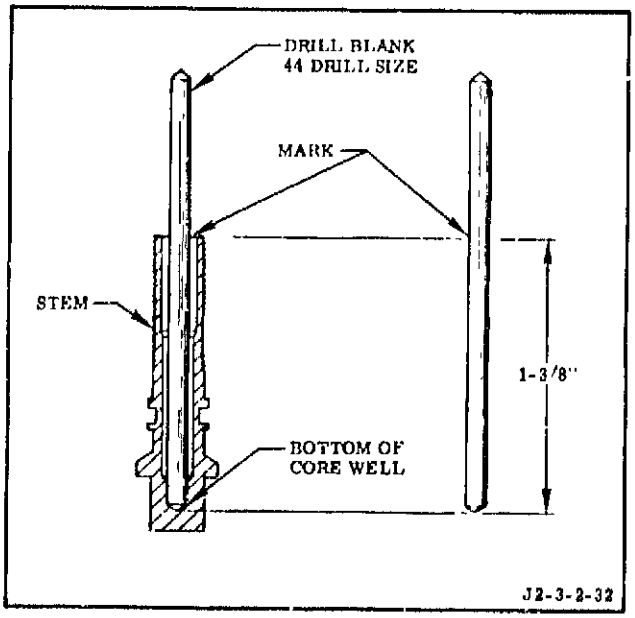


Figure 1-4. Measuring Core Well

f. Clean (paragraph 1-5) new core (4).

g. Using core removal tool, install new core (4). Do not tighten.

CAUTION

The core must not be torqued with a wrench calibrated in in-lb, since damage to the core and/or valve will result.

h. Torque core (4) to 24 ±5 in-oz.

hA. If core stem protrudes above the valve body opening, measure amount of protrusion. If core stem protrusion exceeds 0.010 inch, replace core.

i. Install cap (1). Torque cap to 20-25 in-lb.

j. Until ready for testing, package air filler valve. (Refer to R-3825-3, Volume I.)

1-7. REPLACING PACKING. (Figure 1-3.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Remove cap (1).

CAUTION

Swivel nut or stem must not be interchanged from valve to valve. Swivel nut and stem must be retained as a unit.

c. On swivel nut (2), hold 3/4-inch hex nut, loosen 5/8-inch nut by turning counterclockwise, and separate swivel nut (2) and stem (5).

CAUTION

The use of steel instruments to remove packing can damage stem.

d. Remove packing (3) from stem (5) using a plastic or brass tool. Discard packing.

e. Install packing (3) on stem (5) by rolling packing over stem threads into position in packing groove.

f. Thread swivel nut (2) onto stem (5).

g. Hold 3/4-inch hex nut on swivel nut (2) and apply 100 ±5 in-lb of torque to 5/8-inch nut.

h Install cap (1). Torque cap to 20-25 in-lb.

i. Until ready for testing, package air filler valve. (Refer to R-3825-3, Volume I.)

1-8. TESTING.

1-9. Testing air filler valves consists of leak testing with a mass spectrometer.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment and materials, or their equivalents:

(1) Leak detector, type 24-120A or 24-120B (Consolidated Electrodynamics). (Part of components adapter set 9016796.)

(2) Pressure test fixture T-5047377.

(3) No. 27 hypodermic needle.

(4) Electrical package pressure monitor adapter 9019530-21. (Part of spark igniter cable pressurization tool kit 9025125.)

(5) Gaseous helium (5 psig maximum) to flow on valve to determine leakage. Helium must conform to pressurizing and purging requirements in R-3825-3, Volume I.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Assemble leak detector and perform applicable pretest operating procedures according to applicable leak detector operating manual. Technical Manual R-3825-5, Volume II, contains operating procedures for leak detector set included in components adapter set 9016796.

d. Record sensitivity calculated during pretest operating procedures in figure 1-5 as value S, under Packing, Core, and Seat columns.

e. Install pressure test fixture in leak detector test port.

UNKNOWN-LEAK FORMULA

$X = F \times G \times S$

		Leakage At		
		Packing	Core	Seat
MULTIPLIER Switch Setting	F =	____	____	____
OUTPUT meter indication	G =	____	____	____
Sensitivity	S =	____	____	____
Atmospheric cubic centimeters/sec	X =	____	____	____

Figure 1-5. Calculating Leakage

CAUTION

Torque must not be applied to air filler valve 5/8-inch nut, since damage can result.

f. Install air filler valve into pressure test fixture. Use a new valve packing. Hold test fixture and torque air filler valve 3/4-inch hex nut to 200 ±10 in-lb.

g. Loosen air filler valve 5/8-inch nut one to 2 full turns while holding 3/4-inch hex nut.

h. Using leak detector vacuum pump, evacuate test setup.

i. Connect No. 27 hypodermic needle to low-pressure (0-5 psig) source of gaseous helium.

WARNING

A sudden burst of pressure to the helium supply hose can blow the hypodermic needle from the hose, causing serious injury to personnel and damage to equipment.

j. Slowly open helium supply valve until flow of helium is obtained.

k. Flow helium from hypodermic needle completely around top and bottom of 5/8-inch nut while observing leak detector OUTPUT or LEAKAGE meter. Note meter indication and close helium supply valve.

l. Record meter indication (to nearest scale division) as value G in figure 1-5 in Packing column.

m. Record numerical setting of MULTIPLIER or SCALE detector switch as value F in figure 1-5 in Packing column.

n. Calculate helium leakage and record as value X in figure 1-5 in Packing column. The maximum allowable leakage is 3.0×10^{-7} atm cc/sec. If leakage is excessive, replace packing as outlined in paragraph 1-7 and repeat test. Make sure packing that seals pressure test fixture to air filler valve is not leaking before replacing stem packing.

o. Remove air filler valve cap.

p. Turn core depressor on pressure monitor adapter by hand fully counterclockwise and carefully install adapter on air filler valve (figure 1-6).

q. Run adapter swivel nut onto valve stem by hand until adapter seal contacts valve stem. Carefully tighten adapter swivel nut 1/2 to one turn.

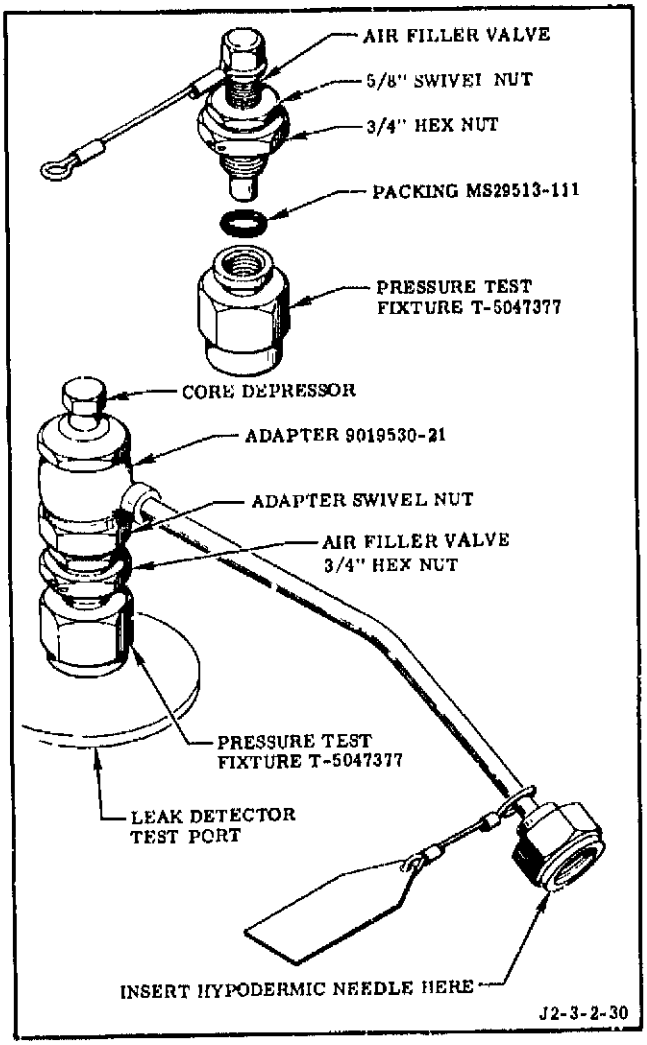


Figure 1-6. Air Filler Valve Test Setup

WARNING

A sudden burst of pressure to the helium supply hose can blow the hypodermic needle from the hose, causing serious injury to personnel and damage to equipment.

r. Slowly open helium supply valve until flow of helium is obtained from hypodermic needle. Helium pressure must not exceed 5 psig.

s. Insert tip of hypodermic needle into open end of pressure monitor adapter while observing leak detector OUTPUT or LEAKAGE meter. Note meter indication and close helium supply valve.

t. Record meter indication (to nearest scale division) as value G in figure 1-5 in Core column.

u. Record numerical setting of MULTIPLIER or SCALE selector switch as value F in figure 1-5 in Core column.

v. Calculate helium leakage and record as value X in figure 1-5 in Core column. The maximum allowable leakage is 3.0×10^{-7} atm cc/sec. If leakage is excessive, replace core as outlined in paragraph 1-6 and repeat test. If leakage continues, valve must be replaced.

w. Carefully remove pressure monitor adapter from air filler valve stem.

x. Hold 3/4-inch hex nut and torque 5/8-inch nut to 100 ±5 in-lb.

y. Carefully install pressure monitor adapter and turn core depressor by hand fully clockwise. Do not use wrench.

WARNING

A sudden burst of pressure to the helium supply hose can blow the hypodermic needle from the hose, causing serious injury to personnel and damage to equipment.

z. Slowly open helium supply valve until flow of helium is obtained from hypodermic needle. Helium pressure must not exceed 5 psig.

aa. Insert tip of hypodermic needle in open end of pressure monitor adapter while observing leak detector OUTPUT or LEAKAGE meter. Note meter indication and close helium supply valve.

ab. Record meter indication (to nearest scale division) as value G in figure 1-5 in Seat column.

ac. Record numerical setting of MULTIPLIER or SCALE selector switch as value F in figure 1-5 in Seat column.

ad. Calculate helium leakage and record as value X in figure 1-5 in Seat column. The maximum allowable leakage is 3.0×10^{-7} atm cc/sec. If leakage is excessive, replace valve.

ae. Rotate core depressor by hand fully counterclockwise and remove pressure monitor adapter from air filler valve.

af. Install cap on air filler valve and torque to 20-25 in-lb.

ag. Remove air filler valve from pressure test fixture by holding hex nut of test fixture and loosening 3/4-inch hex nut of air filler valve.

ah. Package air filler valve. Refer to R-3825-3, Volume I.

ai. Remove pressure test fixture.

aj. Install closure on leak detector test port.

ak. Shut down leak detector set using applicable portion of operating procedures in R-3825-5, Volume II, or equivalent document.

SECTION II

ARMORED HARNESSES

2-1. SCOPE. This section contains repairing and preinstallation test requirements for armored harnesses.

2-2. REPAIRING.

2-3. Field repair of armored harnesses is limited to replacement or repair of damaged components as outlined in fugure 2-1. See figure 2-2 for construction details of a typical armored harness.

2-4. REPAIRING GREEN OVERMOLDS.

a. Obtain the following equipment and materials, or their equivalent:

(1) Methyl-ethyl-ketone (Federal Specification TT-M-261).

(2) Clean, lint-free cloths.

(3) Silicone rubber tape ST0130RB0078, Type I (Rocketdyne).

Part Name	Feature or Condition	Disposition
Connector	Refer to R-3825-3, Volume I, for damage limits.	Replace harness if connector is damaged beyond acceptable limits.
Harness	Abrasions in armor braid not exceeding one inch of continuous linear length in any one area.	Solder over exposed area with lead-tin solder Sn60 or Sn63 (QQ-S-571, Type RA).
	Raised braid.	Permissible if increase in harness diameter does not exceed 5 percent in harness cross-sectional area and braid is unbroken.
	Loose metallic braid separated more than 0.150 inch or where more than one percent of rubber tubing is visible through braid in any one linear foot of harness.	Repair nickel-clad copper armor braided harnesses as outlined in paragraph 2-11. Replace stainless steel armor braided harnesses.
	Random individual broken strands.	Clip off broken strands flush with braid surface; soldering such strands is not required.
	Broken carriers not exceeding 2 complete carriers at any one point and not more than 5 such points within any 2-foot length of harness.	Clip off broken strands flush with braid surface and solder over damaged area with lead-tin solder Sn60 or Sn63 (QQ-S-571, Type RA).

Figure 2-1. Field Repair Limits (Sheet 1 of 3)

Part Name	Feature or Condition	Disposition
	Armor braid damaged beyond the limitations listed above but damage does not exceed 3 continuous linear inches.	Repair nickel-clad copper armor braided harnesses as outlined in paragraph 2-11. Replace stainless steel armor braided harnesses.
	Cut wire insulation.	Replace harness.
	Contamination.	Clean. Refer to R-3825-3, Volume I.
Green or black overmold (polyurethane)	Voids or gouges larger than 1/4 inch in diameter.	Repair as outlined in paragraph 2-4 or 2-5 as applicable.
	Cracks, cuts, or holes that expose armor braid.	Repair as outlined in paragraph 2-4 or 2-5 as applicable.
	Thermal damage.	Sand charred overmold to a smooth finish. If braid is exposed after sanding, repair as outlined in paragraph 2-4 or 2-5 as applicable.

CAUTION

The overmold must not be flexed, pryed, or pulled away from the armor braid or other surface on which it is positioned.

NOTE

Heat-shrinkable overmolds are not intended as a moisture seal.

Heat-shrinkable overmold (black silicone rubber)	Blisters, holes, scratches, or gouges larger than 1/8 inch in diameter.	Replace as outlined in paragraph 2-6.
	Voids larger than 1/4 inch between overmold and armor braid.	Apply aerospace sealant 92-018 (Dow Corning Corp) to affected area.
	Unbonded areas at each end of overmold.	Acceptable if overmold is not loose or slipping on harness.
	Thermal damage.	Sand charred overmold to a smooth finish. If braid is exposed after sanding, replace as outlined in paragraph 2-6.

Figure 2-1. Field Repair Limits (Sheet 2 of 3)

Part Name	Feature or Condition	Disposition
Heat-shrinkable tubing	Blisters, nicks, or scratches larger than 1/8 inch in diameter.	Repair or replace as outlined in paragraph 2-7.
	Cuts one inch or less in length and no damage to wire insulation.	Repair as outlined in paragraph 2-7.
Thermal protecting boot	Surface scratches, nicks, or gouges exceeding 1/8 inch in diameter and more than 0.030 inch deep.	Replace boot.
	Torn ears on boot.	Repair as outlined in paragraph 2-10.

Figure 2-1. Field Repair Limits (Sheet 3 of 3)

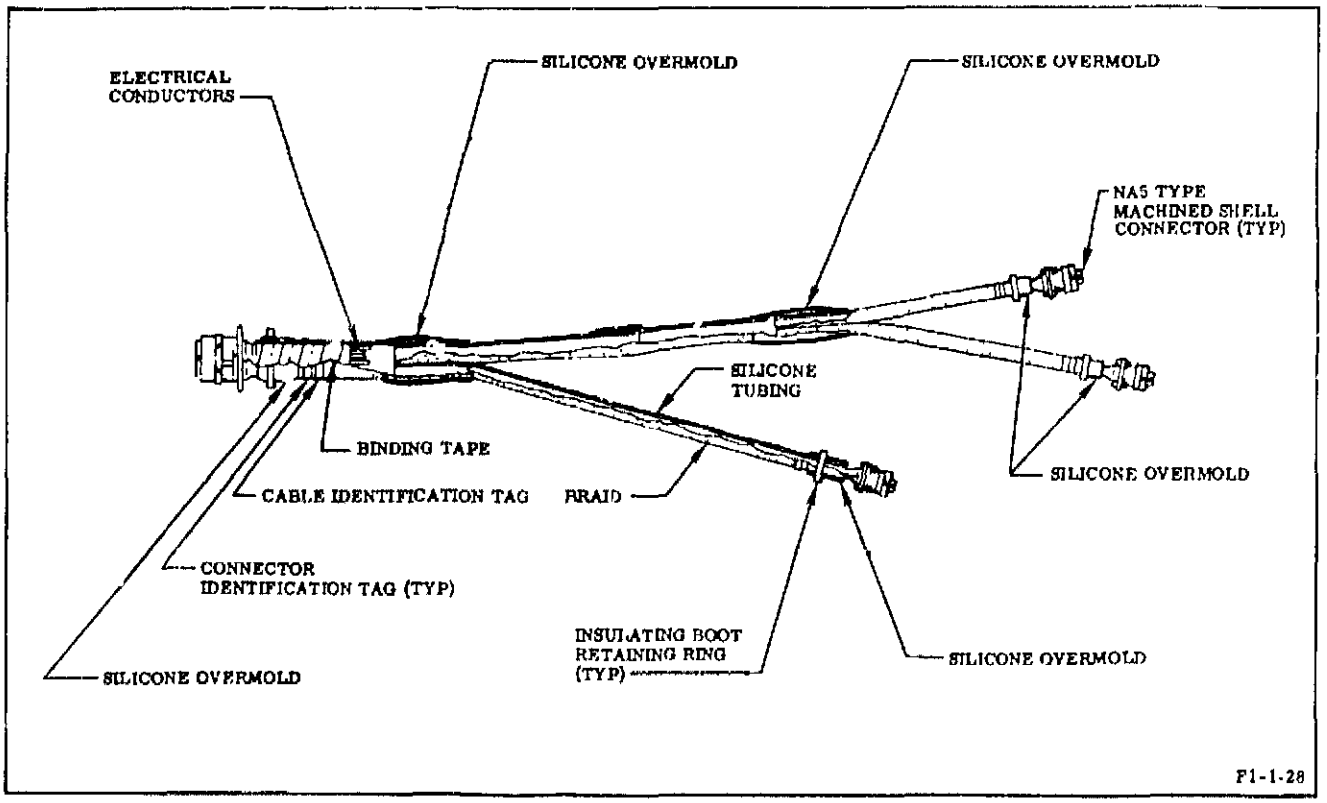


Figure 2-2. Construction Details of Typical Armored Harness

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

c. Clean repair area by wiping with clean, lint-free cloth, dampened with methyl-ethyl-ketone (TT-M-261). Allow solvent to dry completely.

d. Wrap defective or damaged area of overmold with silicone rubber tape applied in one even layer with a 50-percent overlap. Extend tape layer from 1/2 to 1 inch beyond defective or damaged area.

2-5. REPAIRING BLACK OVERMOLDS.

a. Obtain the following equipment and materials, or their equivalents:

(1) Methyl-ethyl-ketone (Federal Specification TT-M-261).

(2) Clean, lint-free cloths.

(3) Potting compound PR-1553 (Products Research and Chemical, Semco).

(4) Spatula to apply potting compound.

(5) Hot-air gun or heat lamp to accelerate curing of potting compound. (This item optional, since potting compound will cure at ambient temperature.)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

c. Clean repair area by wiping with clean, lint-free cloth dampened with methyl-ethyl-ketone (TT-M-261). Allow solvent to dry completely.

WARNING

The following procedure specifies potting compound PR-1553, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

d. Thoroughly mix 22 parts of A to 100 parts of B, by weight, of potting compound.

NOTE

The potting compound starts to set 15 minutes after mixing.

e. Using spatula, apply and smooth potting compound to damaged area of overmold.

f. Allow potting compound to cure at room temperature for approximately 16 hours.

NOTE

Curing may be accelerated by a hot-air gun or heat lamp not exceeding a maximum temperature of 230° F.

g. Remove any excess compound by carefully trimming or sanding.

2-6. REPAIRING HEAT-SHRINKABLE OVERMOLDS. Repairing heat-shrinkable overmolds consists of replacing the damaged item with a new one of the same part number. (See figure 2-3 for replacing overmolds.)

a. Obtain the following equipment and material, or their equivalents:

(1) Methyl-ethyl-ketone (Federal Specification TT-M-261).

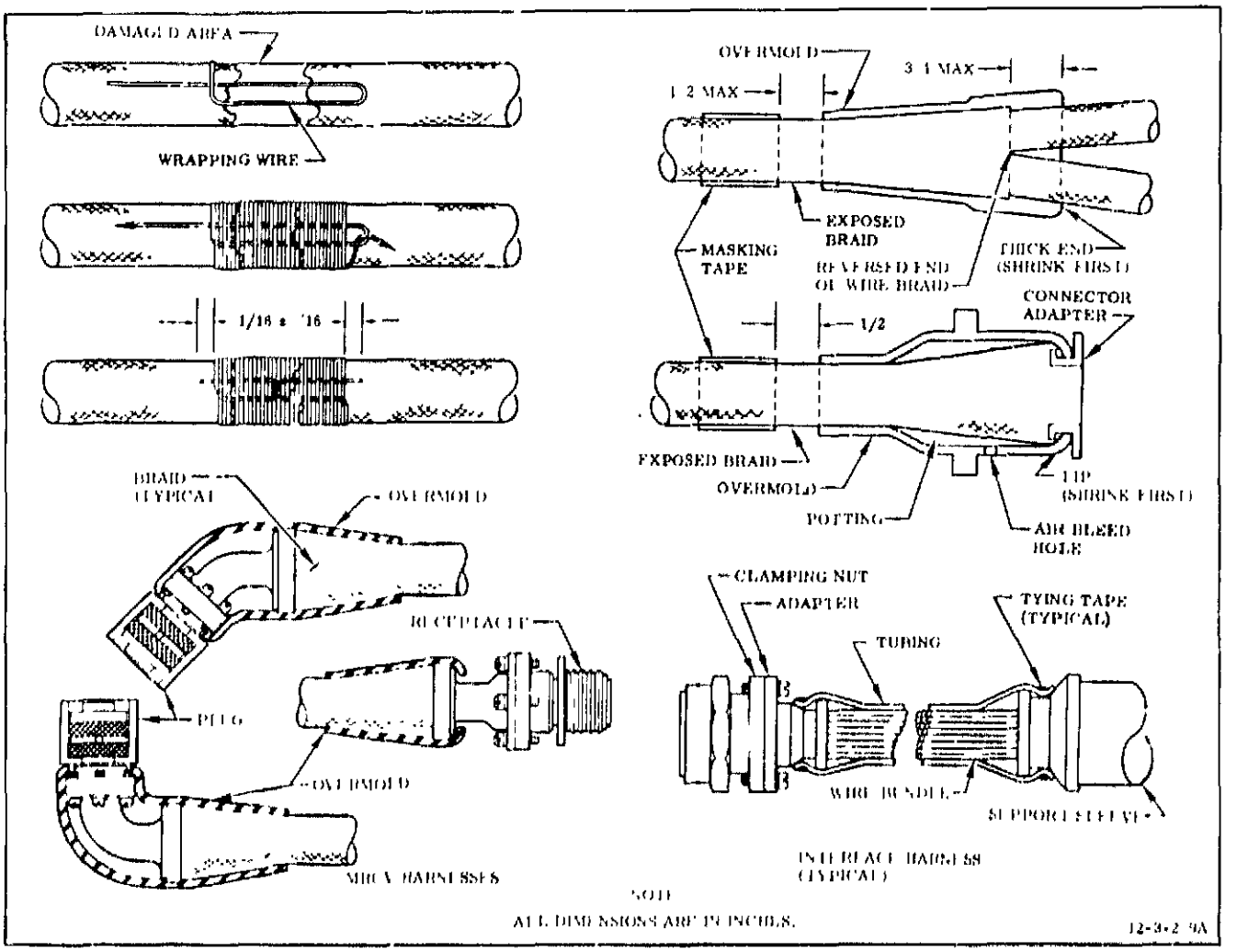


Figure 2-3. Wrapping Armor Braid and Replacing Heat-Shrinkable Overmolds and Tubing

(2) Clean, lint-free cloths.

(3) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(4) Primer 1200 RTV (Dow Corning Corp).

(5) Aerospace sealant 92-018 (Dow Corning Corp).

(6) Heat-gun to shrink overmold.

(7) Natural bristle brush to remove excess sealant. Clean, lint-free cloths may be substituted.

(8) Sharp knife to cut damaged overmold.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

CAUTION

Care must be used when cutting overmold to prevent damage to armor braid.

c. Verify part number of damaged overmold; then carefully remove damaged overmold by cutting overmold with sharp knife along axial length of harness.

d. Peel enough sealant from repair area to expose armor braid. (It is not necessary to remove all sealant.)

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

e. Using clean, lint-free cloth dampened with methyl-ethyl-ketone (TT-M-261), clean area to be bonded and inside of new overmold. Allow solvent to dry completely.

f. Using pressure-sensitive tape, mask off each side of repair area, with 1/2-inch-maximum space from ends of overmold.

WARNING

The following procedure specifies primer 1200 RTV, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

g. Apply a thin coat of primer. Apply only enough primer to give a pink tinge to the metal. Allow to dry for a minimum of 60 minutes.

h. Apply aerospace sealant 1/32- to 1/8-inch thick over entire repair area.

i. Position new overmold around harness at repair area. If overmold has a thick end or inside lip, position overmold in correct direction (See figure 2-3).

CAUTION

Applying excessive heat will cause silicone rubber surface to blister.

j. Using heat-gun, apply heat evenly around overmold, starting at one end and continuing to other. If overmold has lip or thick end (see figure 2-3) completely shrink these ends first. Apply no more heat than is necessary to produce complete shrinking.

k. Using brush or clean cloth dampened with methyl-ethyl-ketone (TT-M-261), immediately remove sealant protruding from part.

l. Remove pressure-sensitive tape.

m. Allow sealant to cure at ambient temperature for a minimum of 16 hours. Do not bend or twist repaired section if harness is handled during curing period.

n. If voids are detected under the molded part, inject sealant through part to fill void.

2-7. REPAIRING HEAT-SHRINKABLE TUBING. Repairing heat-shrinkable tubing consists of repairing cuts of one inch or less (paragraph 2-8), or replacing tubing (paragraph 2-9).

2-8. Repairing Cuts (One Inch or Less).

a. Obtain the following equipment and material, or their equivalents:

(1) Methyl-ethyl-ketone (Federal Specification TT-M-261).

(2) Lint-free cloths.

(3) Aerospace sealant 92-018 (Dow Corning Corp).

(4) Heat-gun to shrink tubing.

(5) Natural bristle brush to remove excess sealant. Clean, lint-free cloths may be substituted.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Verify part number of damaged tubing and obtain a tube with same part number.

d. Cut tubing long enough to overlap damaged area at each end one-half to one inch, after shrinking is complete.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

e. Clean entire circumference of tubing at repair area to be bonded and inside of new tubing using clean, lint-free cloth dampened with methyl-ethyl-ketone (TT-M-261). Allow solvent to dry completely.

f. Apply a thin layer (1/32 inch) of aerospace sealant to entire circumference of tubing at repair area.

CAUTION

Applying excessive heat will cause silicone rubber surface to blister.

g. Center new tubing over repair area and, using heat-gun, apply heat evenly around tube, starting at one end and continuing to other end. Apply no more heat than is necessary to produce complete shrinking.

h. Using brush or clean cloth dampened with methyl-ethyl-ketone (TT-M-261), immediately remove sealant protruding from part.

i. Allow sealant to cure at ambient temperature for a minimum of 16 hours. Do not bend or twist repaired section if harness is handled during curing period.

2-9. Replacing Damaged Heat-Shrinkable Tubing.

a. Obtain the following equipment and materials, or their equivalents.

(1) Sharp knife to cut tubing.

(2) Methyl-ethyl-ketone (Federal Specification TT-M-261).

(3) Clean, lint-free cloths.

(4) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(5) Primer 1200 RTV (Dow Corning Corp).

(6) Aerospace sealant 92-018 (Dow Corning Corp).

(7) Tying tape RB0150-026 (Rocketdyne).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

CAUTION

Care must be used when cutting tubing to prevent damage to wires.

c. Verify part number of damaged tubing; then carefully remove damaged tubing by cutting with knife along axial length of harness.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

d. Using clean, lint-free cloth dampened with methyl-ethyl-ketone (TT-M-261), clean braid retaining grooves and inside of new tubing. Allow solvent to dry completely.

e. Using pressure-sensitive tape, mask off each side of repair area.

WARNING

The following procedure specifies primer 1200 RTV, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

f. Apply a thin coat of primer to metal surface of repair area. Apply only enough primer to give a pink tinge to the metal and allow to dry for a minimum of 60 minutes.

g. Apply aerospace sealant 1/16- to 1/8-inch thick into braid retaining grooves.

h. Center new tubing over repair area and, using heat-gun, apply heat evenly around tube, starting at one end and continuing to other end. Apply no more heat than is necessary to produce complete shrinking. While tube is still at shrinking temperature, perform step i.

i. With tube at shrinking temperature, wrap 4-6 turns of tying tape over tubing in braid retaining grooves and cover with aerospace sealant.

j. Using brush or clean cloth dampened with methyl-ethyl-ketone (TT-M-261), immediately remove sealant protruding from part.

k. Trim excess tubing extending past braid retaining grooves.

l. Allow sealant to cure at ambient temperature for a minimum of 16 hours. Do not bend or twist repaired section if harness is handled during curing period.

2-10. REPAIRING THERMAL PROTECTING BOOT. Repairing the thermal protecting boot consists of repairing torn ears.

a. Obtain the following equipment and materials, or their equivalents:

(1) Isopropyl alcohol (Federal Specification TT-I-735).

(2) Aerospace sealant 92-018 (Dow Corning Corp).

(3) Clean, lint-free cloths.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

The following procedure specifies isopropyl alcohol, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

c. Using clean cloth dampened with isopropyl alcohol (TT-I-735), clean damaged area and surfaces to be joined. Allow cleaned surfaces to dry completely.

d. Punch a hole in boot at end of crack or tear.

e. Apply a thin film of aerospace sealant to surfaces to be joined. Join surfaces; then remove excess sealant.

f. Allow sealant to cure at ambient temperature for a minimum of 16 hours.

2-11. REPAIRING ARMOR BRAID. This procedure is applicable to harnesses with nickel-clad copper armor braid only.

a. Obtain the following equipment and materials, or their equivalents:

(1) Wrapping wire. Kulgrid or Kulgrid 28 (Sylvania Electric Products, Inc) in 24-27 awg. Awg 25 recommended.

(2) Lead-tin solder Sn60 or Sn63 (Federal Specification QQ-S-571, Type RA).

(3) Solder iron or gun.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Lay a loop of wrapping wire axially along harness, spanning damage area plus 1/4 inch minimum as shown in figure 2-3.

d. Spirally wrap harness with tightly butted coils over wire loop (step c) until loop protrudes from spiral coil 1/6 ±1/32 inch.

e. Pull wrapping end of wire through end of loop and pull the 2 ends in an axial direction to snug the spiral coil, with loop end positioned approximately in center of wrapped area.

f. Trim ends of wire to 1/6 ±1/16 inch of wrapped area and solder them to existing braid.

2-12. PREINSTALLATION TESTING.

2-13. The preinstallation tests consist of a continuity-test (paragraph 2-14) and an insulation resistance-test (paragraph 2-15). See figure 2-4 for a list of, and pin to pin wiring of, armored harnesses.

2-14. CONTINUITY.

a. Obtain a multimeter, Model 260 (Simpson), or equivalent.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Using multimeter, perform continuity-test including any wiring to harness shield. See figure 2-4 for harness wiring. Resistance must not exceed one ohm.

2-15. INSULATION RESISTANCE.

a. Obtain a megohmmeter capable of applying 500 vdc, and if harness to be tested has ceramic inserts, low-pressure gaseous nitrogen (MIL-P-27401) to dry inserts.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

High-voltage tests are dangerous; therefore, in addition to local and standard safety requirements, the test equipment must be grounded, connectors must be dry, and personnel must be kept to a minimum in the test area.

c. Thoroughly dry all harness connectors that contain ceramic inserts with low-pressure gaseous nitrogen (MIL-P-27401) before proceeding with this test.

d. Using megohmmeter, apply 500 vdc for 5-60 seconds between each contact and connector shell, and each contact with every other contact in the same connector, except those contacts that are interconnected or connected to the shielding. Resistance of each application must exceed 200 megohms. (See figure 2-4 for harness wiring.)

Wiring Information, Harness	Is in Group	Wiring Information, Harness	Is in Group	Wiring Information, Harness	Is in Group	Wiring Information, Harness	Is in Group
502078-11	6	503266	7	704479	8	704491	14
502079	1	702626	9	704480	12	704491-11	14
502265	2	702626-11	9	704481	14	704492	17
502951	4	702631-11	8	704482	17	704492-11	17
520951-11	4	702632-11	13	704483	19	704493	18
502968	3	702633-11	14	704484	16	704493-11	18
503157	5	702639-11	17	704485	15	704494	19
503158	3	702641-11	19	704486	21	704494-11	19
503159	6	702647-11	16	704486-11	21	704495	16
503160	1	703246-11	15	704487	11	704495-11	16
503164	6	703248-11	20	704488	18	704496	15
503164-11	6	703250	11	704489	8	704496-11	15
503165	1	703250-11	11	704489-11	8	704497	20
503165-11	1	704107	18	704490	13	704497-11	20
503166	3	704478	10	704490-11	13	704562	22
503166-11	3						

Figure 2-4. Armored Harness Wiring (Sheet 1 of 6)

Group	From	To
1	Harness 502079-11, 503160, 503165, or 503165-11	
	P1-M	P25-A
	P1-N	P25-B
	P1-C	P25-C
	P1-D	P25-D
	P1-E	P25-E
	P1-K	P25-F
	P1-J	P25-G
	P1-H	P25-H
	P1-I	P25-I
	P1-A	P51-A
	P1-B	P51-B
	P1-F	P51-F
	P1-G	P51-G
	P1-L	P51-L
	P1-O	P51-O
	P1-P	P51-P
	P1-R	P51-R
	P1-S	P51-S
	P1-T	P51-T
	P1-U	P51-U
	P1-V	P51-V
	P1-W	P51-W
	P1-X	P51-X
	P1-Y	P51-Y
	P1-Z	P51-Z
	P1-a	P51-a
	P1-b	P51-b
	P1-c	P51-c
	P1-d	P51-d
	P1-e	P51-e
	P1-f	P51-f
	P1-g	P51-g
	P1-h	P51-h
	P1-j	P51-j
	P1-k(a)	Shield
	P51-k(a)	Shield
2	Harness 502265	
	P55-A	P180-C
	P55-B	P180-B
3	Harness 502968, 503158, 503166, or 503166-11	
	P2-z(a)	Shield
	P54-z(a)	Shield
	Remaining wires go from pin to pin.	
4	Harness 502951 or 502951-11	
	P3-g	P13-A
	P3-W	P13-B
	P3-T	P14-A
	P3-L	P14-B
	P3-h	P15-A
	P3-c	P15-B
	P3-P	P16-A
	P3-H	P16-B
	P3-J	P16-C
	P3-n	P17-A
	P3-d	P17-B
	P3-R	P17-D
	P3-b	P18-A
	P3-U	P18-B
	P3-r	P19-A
	P3-p	P19-B
	P3-j	P19-C
	P3-V	P19-D
	P3-D	P20-A
	P3-F	P20-B
	P3-M	P20-C
	P3-N	P21-A
	P3-G	P21-B
	P3-e	P22-A
	P3-k	P22-B
	P3-m	P22-C
	P3-K	P26-A
	P3-E	P26-B
	P3-S	P26-C
	P13-C	P18-D
	P13-D	P17-C
	P14-C	P15-D
	P14-D	P18-C
	P15-C	P19-E
	P3-s	Shield

(a) Shield continuity test between these contacts only.

Figure 2-4. Armored Harness Wiring (Sheet 2 of 6)

Group	From	To
5	Harness 503157	
	P3-g	P13-A
	P3-W	P13-B
	P3-T	P14-A
	P3-L	P14-B
	P3-h	P15-A
	P3-c	P15-B
	P3-R	P15-C
	P3-P	P16-A
	P3-H	P16-B
	P3-J	P16-C
	P3-n	P17-A
	P3-d	P17-D
	P3-b	P18-A
	P3-U	P18-B
	P3-r	P19-A
	P3-p	P19-B
	P3-j	P19-C
	P3-V	P19-E
	P3-D	P20-A
	P3-F	P20-B
	P3-M	P30-C
	P3-N	P21-A
	P3-G	P21-B
	P3-e	P22-A
	P3-k	P22-B
	P3-m	P22-C
	P3-K	P26-A
	P3-E	P26-B
	P13-S	P26-C
	P13-C	P15-D
	P13-D	P17-C
	P14-C	P17-D
	P14-D	P18-C
	P18-D	P19-D
	P3-g(a)	Shield
6	Harness 502078-11, 503150, 503164, or 503164-11	
	P36	P38
	P38-T(a)	Shield
	Remaining wires go from pin to pin.	
7	Harness 503206	
	J36A-A	P36A-A
	J36A-B	P36A-B
8	Harness 702631-11, 704479, 704489, or 704489-11	
	P100	P105
	All wires go from pin to pin.	
9	Harness 702626 or 702626-11	
	P101-y	P114-E
	P101-m	P115-E
	P101-c	P116-E
	P101-V	P118-E
	P101-Q	P119-E
	P101-O	P120-B
	P101-K	P132-A
	P101-M	P133-A
	P101-x	P114-A
	P101-s	P115-A
	P101-k	P116-A
	P101-c	P117-A
	P101-g	P118-A
	P101-U	P119-A
	P101-t	P114-D
	P101-u	P114-F
	P101-v	P114-B
	P101-w	P114-C
	P101-n	P115-D
	P101-p	P115-F
	P101-q	P115-B
	P101-r	P115-C
	P101-e	P116-D
	P101-f	P116-F
	P101-h	P116-B
	P101-j	P116-C
	P101-L	P132-B
	P101-N	P133-B
	P101-a	P117-B
	P101-b	P117-C
	P101-W	P118-D
	P101-X	P118-F
	P101-Y	P118-B
	P101-Z	P118-C
	P101-R	P119-D
	P101-S	P119-B
	P101-T	P119-C
	P101-P	P120-A
	P117-E	J25-C
	P117-D	J25-B
	P117-F	J25-A

(a) Shield continuity test between these contacts only.

Figure 2-4. Armored Harness Wiring (Sheet 3 of 6)

Group	From	To
10	Harness 704478	
	P101-y	P114-E
	P101-m	P115-E
	P101-d	P116-E
	P101-V	P118-E
	P101-O	P120-B
	P101-K	P132-A
	P101-M	P133-A
	P101-x	P114-A
	P101-s	P115-A
	P101-k	P116-A
	P101-c	P117-A
	P101-g	P118-A
	P101-U	P119-A
	P101-t	P114-D
	P101-u	P114-F
	P101-v	P114-B
	P101-w	P114-C
	P101-n	P115-D
	P101-p	P115-F
	P101-q	P115-B
	P101-r	P115-C
	P101-e	P116-D
	P101-f	P116-F
	P101-h	P116-B
	P101-j	P116-C
	P101-T	P132-B
	P101-N	P133-B
	P101-a	P117-B
	P101-b	P117-C
	P101-W	P118-D
	P101-X	P118-F
	P101-Y	P118-B
	P101-Z	P118-C
	P101-S	P119-B
	P101-T	P119-C
	P101-P	P120-A
	P117-E	J25-C
	P117-F	J25-A
	P117-D	J25-B

Group	From	To
11	Harness 703250, 703250-11, or 704487	
	P102-R	P141-A
	P102-S	P141-D
	P102-G	P141-C
	P102-H	P141-B
	P102-E	P141-E
	P102-F	P141-F
	P102-V(a)	Shield
12	Harness 704480	
	P103-s(a)	Shield
	P106-s(a)	Shield
	Remaining wires go from pin to pin.	
13	Harness 702632-11, 704490 or 704490-11	
	P106	P103
	P106-s	Shield
	All wires go from pin to pin, except P103-s, which is not used.	
14	Harness 702633-11, 704481, 704491, or 704491-11	
	P104	P107
	All wires go from pin to pin.	
15	Harness 703246-11, 704485, 704496, or 704496-11	
	P108-M	P122-A
	P108-U	P122-B
	P108-T	P122-C
	P108-G	P123-A
	P108-J	P123-B
	P108-I	P123-C

(a) Shield continuity test between these contacts only.

Figure 2-4. Armored Harness Wiring (Sheet 4 of 6)

Group	From	To
15 (cont)	P108-H	P123-D
	P108-L	P123-E
	P108-K	P123-F
	P108-e	P124-A
	P108-a	P124-B
	P108-Z	P124-C
	P108-V	P124-D
	P108-R	P124-E
	P108-P	P124-F
	P108-b	P125-A
	P108-X	P125-B
	P108-W	P125-C
	P108-S	P125-D
	P108-O	P125-E
	P108-N	P125-F
	P108-k	P126-A
	P108-d	P126-B
	P108-c	P126-C
	P108-r	P127-A
	P108-j	P127-B
	P108-h	P127-C
	P108-m	P128-A
	P108-q	P128-B
	P108-f	P128-C
	P108-u	P129-A
	P108-p	P129-B
	P108-n	P129-C
	P108-s	P130-A
	P108-x	P130-B
	P108-v	P130-C
	P108-t	P131-A
	P108-y	P131-B
	P108-w	P131-C
	P108-Z(a)	Shield
16	Harness 702647-11, 704484, 704494, or 704495-11	
	P109-P	P110-A
	P109-N	P110-B
	P109-K	P110-C
	P109-J	P110-D
	P109-U	P111-A
	P109-T	P111-B
	P109-S	P111-C
	P109-R	P111-D
	P109-D	P112-A
	P109-C	P112-B
	P109-B	P112-C
	P109-A	P112-D
	P109-H	P113-A
	P109-G	P113-B
	P109-F	P113-C
	P109-E	P113-D
	P109-V(a)	Shield
17	Harness 702639-11, 704482, 704492, or 704492-11	
	P150-I	P153-K
	Remaining wires go from pin to pin, except P153-L, -M, -N, and -P, which are not wired.	
18	Harness 704107, 704488, 704493, or 704493-11	
	P151	P154
	P154-z(a)	Shield
	Remaining wires go from pin to pin, except P151-z, which is not wired.	
19	Harness 702641-11, 704483, 704494, or 704494-11	
	P152-P	P155-A
	P152-R	P155-B
	P152-S	P155-C
	P152-T	P155-D
	P152-m	P155-E
	P152-f	P155-F
	P152-Z	P155-G
	P152-V	P155-H
	P152-U	P155-J
	P152-n	P155-K
	P152-p	P155-L
	P152-r	P155-M
	P152-W	P155-N
	P152-X	P155-P
	P152-a	P155-Q

(a) Shield continuity test between these contacts only.

Figure 2-4. Armored Harness Wiring (Sheet 5 of 6)

Group	From	To
19 (cont)	P152-d	P155-R
	P152-e	P155-S
	P152-k	P155-T
	P152-b	P155-U
	P152-c	P155-V
	P152-g	P155-W
	P152-h	P155-X
	P152-j	P155-Y
20	Harness 703248-11, 704497, or 704497-11	
	P156-Y	P157-A
	P156-J	P157-B
	P156-H	P157-C
	P156-X	P157-D
	P156-G	P157-E
	P156-F	P157-F
	P156-Z	P158-A
	P156-L	P158-B
	P156-K	P158-C
	P156-M	P158-D
	P156-b	P158-E
	P156-a	P158-F
	P156-V	P159-A
	P156-f	P159-B
	P156-e	P159-C
	P156-W	P159-D
	P156-E	P159-E
	P156-D	P159-F
	P156-c	P161-A
	P156-P	P161-B
	P156-N	P161-C
	P156-g	P162-A
	P156-h	P162-B
	P156-j	P162-C
	P156-T	J163-A
	P156-d	J163-B
	P156-k	J163-C
	P156-R	J180-A
	P156-S	J180-B
	P156-Q	J180-C
	P156-m(a)	Shield
21	Harness 704486 or 704486-11	
	P156-Y	P157-A
	P156-J	P157-B
	P156-H	P157-C
	P156-X	P157-D
	P156-G	P157-E
	P156-F	P157-F
	P156-Z	P158-A
	P156-L	P158-B
	P156-K	P158-C
	P156-M	P158-D
	P156-b	P158-E
	P156-a	P158-F
	P156-V	P159-A
	P156-f	P159-B
	P156-e	P159-C
	P156-W	P159-D
	P156-E	P159-E
	P157-D	P159-F
	P156-g	P162-A
	P156-h	P162-B
	P156-j	P162-C
	P156-T	J163-A
	P156-d	J163-B
	P156-k	J163-C
	P156-R	J180-A
	P156-S	J180-B
	P156-Q	J180-C
	P156-m(a)	Shield
22	Harness 704562	
	J119A-C	P119A-A
	J119A-B	P119A-B
	J119A-A	P119A-C

(a) Shield continuity test between these contacts only.

Figure 2-4. Armored Harness Wiring (Sheet 6 of 6)

SECTION III

AUGMENTED AND GAS GENERATOR SPARK IGNITER CABLES

3-1. SCOPE. This section contains allowable field repair data for spark igniter cables.

3-2. REPAIRING.

3-3. Spark igniter cables may be repaired while installed on or removed from the engine. Repair consists of replacing damaged parts on the bell housing end of the cable, repair of the ablative covering, and on cables 651389 and 651390, trimming the grommet sleeve to permit complete pressurization of the cable. See figure 3-1 for description and disposition of spark igniter cable damage. Repair procedures must be performed in a controlled area to prevent contamination.

3-4. REPLACING DAMAGED PARTS.

3-5. Since the disassembly and assembly of spark igniter cables is a simple procedure consisting essentially of removing a retaining ring; then sliding all the removable parts off the connector, a single procedure, one for each type of cable, is used for replacing parts. For disassembly and assembly procedures refer to paragraph 3-6 for spark igniter cables 651389 and 651390 and to paragraph 3-7 for spark igniter cables NA5-27448 and NA5-27448T1.

Damaged Part	Description	Disposition
Retaining ring	Broken, sprung, or bent.	Replace retai g ring as outlined in paragraph 3-4.
Insulator, grommet, or grommet sleeve	Cut, nicked, chipped, or permanently deformed.	Replace damaged parts as outlined in paragraph 3-4.
Connector assembly	Bent or damaged.	Replace igniter cable. (If cable is installed, refer to R-3825-3, Volume I.)
High-tension centerwire	Birdcaged wire strands at connector joint.	Acceptable, provided there are no broken wire strands.
	Broken wire strands at connector joint.	Replace igniter cable. (If cable is installed, refer to R-3825-3, Volume I.)
	Insulation slit, cut, or damaged.	Replace igniter cable. (If cable is installed, refer to R-3825-3, Volume I.)

Figure 3-1. Spark Igniter Cable Damage Limits (Sheet 1 of 2)

Damaged Part	Description	Disposition
Spark igniter cable ablative protective covering	Surface imperfections, nicks, scratches, and cuts one inch in length or less in the covering.	Acceptable, if wire braid or bellows beneath wire braid is not exposed or damaged.
	Nicks, tears, or cuts in ablative protective covering that expose wire braid, but wire braid or bellows beneath wire braid is not damaged.	Repair ablative protective covering as outlined in paragraph 3-9.
Spark igniter cable wire braid	Wire braid has minor damage (nicks or scratches), but no strands are broken and bellows beneath wire braid is not damaged.	Leak test igniter cable. (Refer to R-3825-1B.) If cable passes leak test, repair ablative protective covering. If cable does not pass leak test, replace igniter cable. (If cable is installed, refer to R-3825-3, Volume I.)
	Wire braid has broken strands, or bellows beneath wire braid is damaged.	Replace igniter cable. (If cable is installed, refer to R-3825-3, Volume I.)
Grommet sleeve (Spark Igniter Cables 651389 and 651390 only.)	Too long, preventing complete pressurization of cable.	Trim sleeve as outlined in paragraph 3-8.

Figure 3-1. Spark Igniter Cable Damage Limits (Sheet 2 of 2)

3-6. DISASSEMBLY AND ASSEMBLY OF SPARK IGNITER CABLES 651389 AND 651390. (Figure 3-2.)

a. Obtain the following equipment and materials, or their equivalents.

(1) Tip compressor XEO R914129-D1.

(2) Tip checkout tool XEO R914129-D2.

(3) Retaining ring assembler XEO R914129-D5.

(4) Small crochet hook (No. 10, 11, or 12) or tweezers. Required only if cable has a Teflon insulating sleeve.

(5) Denatured alcohol (MIL-A-6091 or Federal Specification O-E-760).

(6) Nylon cloth No. 7815 (Victor Gloves, Inc).

(7) Clean, lint-free nylon gloves, No. 7862 (Victor Gloves, Inc).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

The following procedure uses denatured alcohol which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

Using unclean tools and failing to keep components in clean condition can contaminate the system and damage the equipment.

c. Clean all tools with nylon cloth moistened with denatured alcohol before using, and use care to keep components in clean condition.

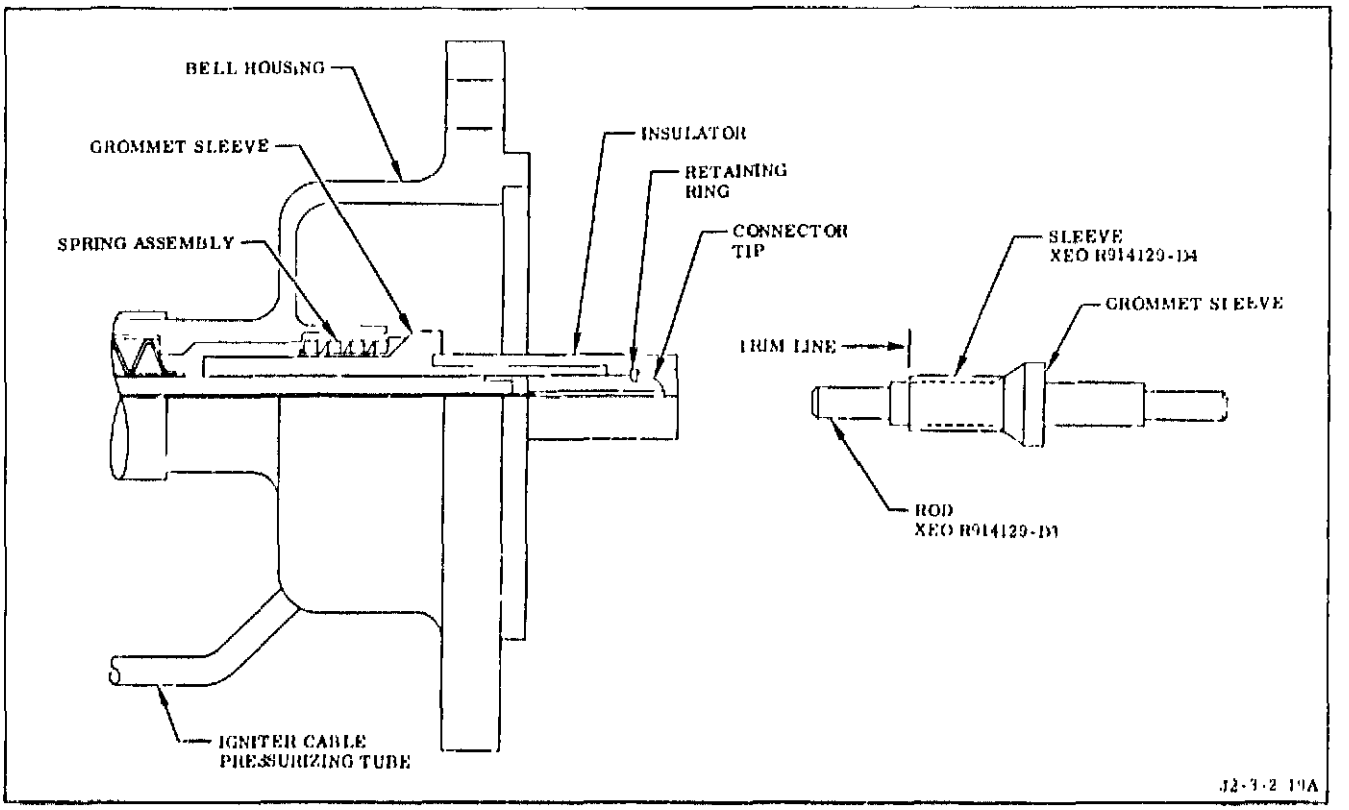


Figure 3-2. Spark Igniter Cables 651389 and 651390

d. Using tip compressor, press straight in on connector tip to release retaining ring. While maintaining pressure on tip, pull insulator straight out. Tip compressor must be held against retaining ring to prevent loss of retaining ring, which is under spring pressure.

e. Relieve pressure against connector tip and remove retaining ring and insulator.

CAUTION

Using pliers or any other tool to grasp the spring and grommet sleeve and/or twisting it other than clockwise (as viewed from flanged end of bell housing) can damage centerwire.

f. Remove grommet sleeve and spring assembly as follows:

(1) Grasp spring assembly and grommet sleeve with fingers. (Do not use pliers or any other tool.)

(2) Twist spring assembly and grommet sleeve clockwise (as viewed from flanged end of bell housing) until grommet sleeve turns freely on centerwire. (Considerable force may be required to loosen and remove spring assembly and grommet sleeve.)

(3) Continue turning spring assembly and grommet sleeve clockwise and pulling out until parts are removed.

g. If there is no Teflon insulating sleeve beneath spring assembly, proceed to next step. If there is a Teflon insulating sleeve, proceed as follows:

(1) Remove and discard Teflon insulating sleeve.

(2) Using a small crochet hook (No. 10, 11, or 12) and/or tweezers, remove potting compound from insulation on centerwire and from bell housing bore, taking care not to damage insulation on centerwire. Do not use solvents to remove potting compound.

(3) Inspect insulation on centerwire. If insulation is damaged, notify Rocketdyne Representative.

h. Discard damaged part(s).

i. Using clean nylon cloth moistened with denatured alcohol, clean exposed centerwire and all parts to be installed inside of bell housing.

CAUTION

Failing to wear clean, lint-free nylon gloves during assembly can contaminate and damage the equipment.

j. Wearing clean, lint-free nylon gloves install spring assembly on grommet sleeve. The inner Teflon insulating sleeve beneath the spring assembly must be left out.

k. Install grommet sleeve and spring assembly on centerwire by grasping grommet sleeve and spring assembly with fingers and pushing and twisting clockwise (as viewed from flanged end of bell housing).

l. Slide insulator over grommet sleeve, and secure with retaining ring. Using retaining ring assembler, seat retaining ring. With retaining ring assembler held in place to prevent loss of retaining ring, pull up on insulator to make sure retaining ring is seated correctly.

m. Slide tip checkout tool into end of tip to spread tip, and verify correct installation of retaining ring. If tool will not slide into tip, repeat steps k and l.

3-7. DISASSEMBLY AND ASSEMBLY OF SPARK IGNITER CABLES NA5-27448 AND NA5-27448T1. (Figure 3-3.)

a. Obtain the following equipment and materials, or their equivalents:

(1) External retaining ring pliers (commercial, for ring MS16624-18).

(2) Denatured alcohol (MIL-A-6091 or Federal Specification O-E-760).

(3) Nylon cloth No. 7815 (Victor Gloves, Inc).

(4) Clean, lint-free nylon gloves No. 7862 (Victor Gloves, Inc).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

The following procedure uses denatured alcohol, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

Excessive bending and twisting of spark igniter cable can damage the cable bellows.

- Bending or twisting spark igniter cable NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the spark igniter cable. (Spark igniter cable NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.

- Using unclean tools and failing to keep components in clean condition can contaminate the system and damage the equipment.

c. Clean all tools with nylon cloth moistened with denatured alcohol before using, and take care to keep components in clean condition.

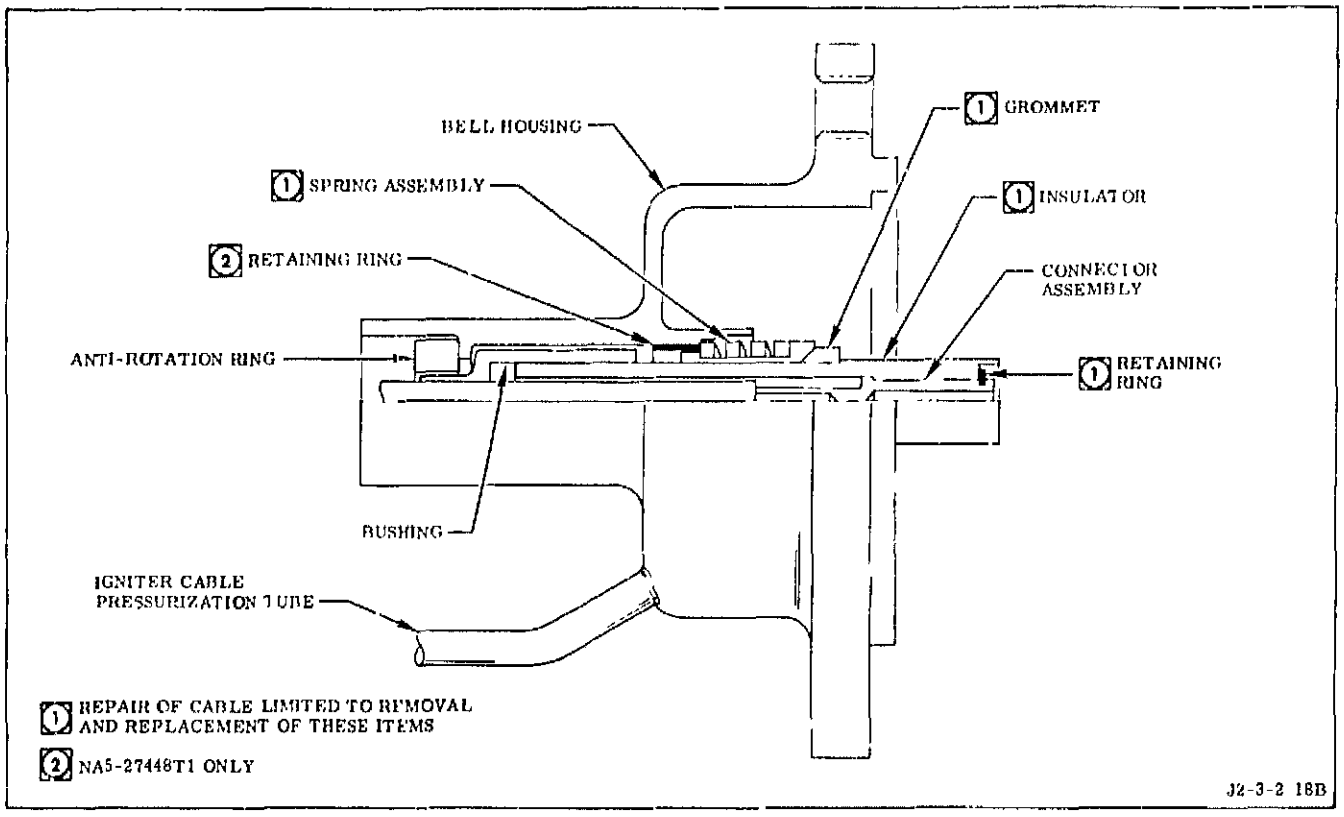


Figure 3-3. Spark Igniter Cables NA5-27448 and NA5-27448T1

d. Remove protective closure from support ST3950166RKL001 on spark igniter cable NA5-27448, or from bell housing of spark igniter cable NA5-27448T1.

e. Remove support ST3950166RKL001 from bell housing of spark igniter cable NA5-27448.

f. Wearing clean, lint-free nylon gloves and using retaining ring pliers, remove retaining ring from connector.

CAUTION

Using pliers or any other tool to grasp the insulator and/or twisting it (other than clockwise as viewed from flanged end of bell housing) can damage centerwire.

g. Remove insulator, grommet, and spring assembly as follows:

(1) Grasp insulator, spring assembly, and grommet with fingers. (Do not use pliers or any other tool.)

(2) Twist insulator, spring assembly, and grommet clockwise (as viewed from flanged end of bell housing) until insulator turns freely on centerwire. (Considerable force may be required to loosen and remove insulator from centerwire.)

(3) Continue turning insulator, spring assembly, and grommet clockwise, while pulling out, until parts are removed.

h. Discard damaged part(s).

i. Using clean nylon cloth moistened with denatured alcohol, clean all parts to be installed, inside of bell housing and exposed centerwire.

CAUTION

Failing to wear clean, lint-free nylon gloves during assembly can contaminate and damage the equipment.

j. Wearing clean, lint-free nylon gloves install grommet and spring assembly on insulator, making sure bevel of spring assembly is against bevel of grommet.

k. Install insulator, grommet, and spring assembly, on centerwire by grasping insulator, grommet, and spring assembly with fingers and pushing and twisting clockwise (as viewed from flanged end of bell housing).

l. Using retaining ring pliers, secure insulator to connector assembly with retaining ring. Pull on insulator to make sure retaining ring is correctly installed.

m. Install support ST3950166RKL001 on bell housing of spark igniter cable NA5-27448 as follows: (Support is not required on spark igniter cable NA5-27448T1.)

(1) Place support ST3950166RKL001 on spark igniter cable bell housing so that plastic plunger in support is seated in spark igniter cable connector. Install bolts and washers in countersunk holes in support.

(2) Tighten bolts until flange on support seats on spark igniter cable bell housing flange.

CAUTION

Incorrect installation of desiccant in protective closure for spark igniter cable NA5-27448T1 can displac desiccant retainer, causing damage to the spark igniter cable connector.

n. Make sure desiccant is correctly installed in spark igniter cable protective closure and desiccant retainer in closure is not displaced.

o. Install clean protective closure on spark igniter cable NA5-27448 support or bell housing of spark igniter cable NA5-27448T1.

3-8. TRIMMING GROMMET SLEEVE. (Figure 3-2.)

a. Obtain the following equipment and materials, or their equivalents.

(1) Rod XEO R914129-D3.

(2) Trimming sleeve XEO R914129-D4.

(3) Denatured alcohol (MIL-A-6091 or Federal Specification O-E-760).

(4) Clean, lint-free nylon gloves No. 7862 (Victor Gloves, Inc).

(5) Nylon cloth No. 7815 (Victor Gloves, Inc).

(6) Sharp knife to trim grommet sleeve.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

The following procedure uses denatured alcohol, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

c. Remove grommet sleeve. Refer to paragraph 3-6 and disassemble cable to point where grommet sleeve is removed.

CAUTION

Failure to wear clean, lint-free nylon gloves during repair and keep components in a clean condition can contaminate and damage the equipment.

d. Wearing clean, lint-free nylon gloves, slide grommet sleeve onto rod. Slide sleeve over grommet sleeve with chamfer of sleeve against bevel of grommet sleeve.

e. With trimming sleeve held firmly against bevel of grommet sleeve, use knife and trim grommet extending beyond trimming sleeve.

f. Remove trimming sleeve and grommet sleeve from rod.

g. Reinstall grommet sleeve and reassemble cable (paragraph 3-6).

3-9. REPAIRING ABLATIVE COVERING. This procedure is applicable to ablative covering whether the covering is heat-shrinkable tubing or tape.

a. Obtain the following equipment and materials, or their equivalents:

(1) Sharp knife to remove damaged covering.

(2) Silicone rubber electrical tape No. 4420 (Connecticut Hard Rubber Co).

b. When performing this procedure, observe safety precautions, and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Using knife, remove a band of ablative covering around cable extending approximately 1/2 inch on either side of damaged area. Take care not to damage braid when removing damaged covering.

d. Using silicone rubber electrical tape, wrap exposed area to a thickness approximately the same as removed covering, overlapping adjacent covering.

SECTION IV

ELECTRICAL CONTROL ASSEMBLY

4-1. SCOPE. This section contains electrical control assembly preinstallation test requirements. Repair information is not included, since the electrical control assembly is not field repairable.

4-2. PREINSTALLATION TESTING.

4-3. The preinstallation test of the electrical control assembly consists of a pressure check. Check pressure as outlined in R-3825-1B, paragraph titled MEASURING PRESSURE IN ELECTRICAL CONTROL ASSEMBLY AND PRIMARY AND AUXILIARY FLIGHT INSTRUMENTATION PACKAGES.

SECTION V

FLIGHT INSTRUMENTATION PACKAGES

5-1. SCOPE. This section contains field repair information and preinstallation test requirements for the primary and auxiliary flight instrumentation packages.

5-2. REPAIRING.

5-3. Repair of the packages is limited to replacing transducers and to that portion of the transducer harness that extends from the package with the transducer removed. Paragraphs 5-4 through 5-9 provide repair information for the harnesses. Transducer replacement is in R-3825-3, Volume I.

5-4. REPLACING TRANSDUCER HARNESS ELECTRICAL CONNECTOR.

5-5. Whether a connector can be replaced depends on the final length of the harness after repair. The harness length after repair must meet the minimum length requirement shown in figure 5-1, to ensure that the harness will not be preloaded in its installed condition. Before replacing a connector, make sure harness will meet the minimum length requirement after the connector has been replaced. If harness will meet the length requirement, remove and install the electrical connector in accordance with paragraph 5-6 and 5-7. If harness will not meet the length requirement, replace the package.

5-6. REMOVING TRANSDUCER HARNESS ELECTRICAL CONNECTOR.

a. When performing this procedure, observe safety precautions and contamination and damage prevention and requirements in R-3825-3, Volume I.

b. Carefully split and remove potting boot from connector.

c. Carefully remove enough potting compound to permit cutting the harness wires to a length that meets, or is in excess of, the minimum repairable wire length shown in figure 5-1.

d. Identify each wire with a piece of tape marked to indicate corresponding pin letter of connector.

e. Cut all wires that are connected to connector. Make sure wires are cut to a length that meets, or is in excess of, minimum repairable wire length shown in figure 5-1.

f. Discard damaged connector.

5-7. INSTALLING TRANSDUCER HARNESS ELECTRICAL CONNECTOR.

a. Obtain the following equipment and materials, or their equivalents:

(1) Isopropyl alcohol (Federal Specification TT-I-735).

(2) Medium-stiff bristle brush.

(3) Lead-tin solder Sn60 or Sn63 (Federal Specification QQ-S-571).

(4) Soldering flux (MIL-F-14256, Type A). (Use of soldering flux is optional.)

(5) Multimeter AN/PSM-6.

(6) Silicone elastomer compound RB0120-005, Type V, Class A (Rocketdyne).

(7) Silicone primer SS-4004 (General Electric).

(8) Natural-bristle brush.

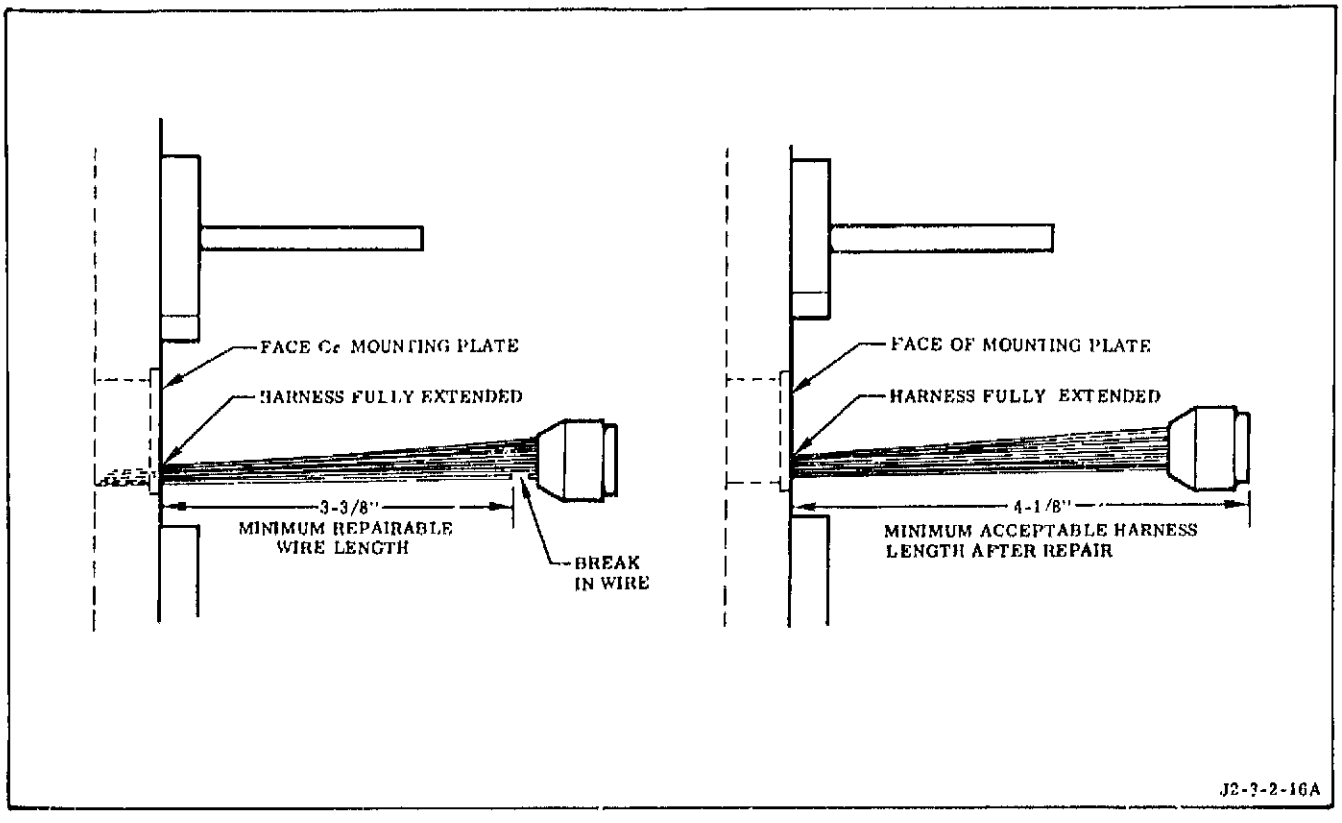


Figure 5-1. Determining Repairable and Acceptable Wire Lengths

(9) Soft-bristle brush.

(10) Thermolite 12 (M&T Chemicals, Inc).

(11) Twelve cubic centimeter disposable polyethylene dispenser (Electronic Production and Development).

(12) Dispenser 250-C2-1/2 (Products Research and Chemical, Semco).

(13) Nozzle 430 (Products Research and Chemical, Semco).

(14) Sealant gun 250-2-1/2 (Products Research and Chemical, Semco).

(15) Wooden spatula.

b. Prepare each wire of transducer harness as follows:

(1) Strip wire end, insert wire end into solder cup of new connector and check for correct gap between end of wire insulation and cup.

WARNING

The following procedure specifies isopropyl alcohol, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

(2) Clean wire end and solder cup with ispropyl alcohol (TT-I-735), using a medium-stiff bristle brush.

(3) Tin wire end with lead-tin solder (QQ-S-571). Soldering flux (MIL-F-14256, Type A) may be used before applying solder to wire end.

c. Slide new potting boot over wires.

d. Install new connector, and solder premarked wires into corresponding solder cups as follows:

NOTE

All oxides, scale, oil, grease and other foreign matter must be removed from surfaces immediately before tinning or soldering.

(1) If necessary, clean wire end and solder cup with isopropyl alcohol (TT-I-735) using a medium-stiff bristle brush.

(2) Insert correct length of lead-tin solder (QQ-S-571) into solder cup, apply heat until solder melts, insert wire end, remove heat, and allow joint to cool.

(3) Inspect solder joint.

e. Using multimeter, test continuity between each connector pin and contacts of corresponding package interface connector. (See figure 5-2 for primary flight instrumentation package transducer harness pin-to-interface-pin connections and figure 5-3 for auxiliary flight instrumentation package transducer harness pin-to-interface-pin connections.) Resistance must not exceed 0.5 ohm.

f. Encapsulate connector with potting compound as follows:

(1) Clean all areas to be contacted by potting compound, including inside of potting boot, with clean alcohol (TT-I-735), using natural-bristle brush. Remove all metal particles, soldering flux, or other foreign materials.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

(2) Allow connector to dry at room temperature for a minimum of one hour. After drying, blow out any dust or foreign particles with low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401).

WARNING

The following procedure specifies silicone primer SS-4004, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

(3) Apply silicone primer to all serfaces on inside of connector with a soft bristle brush until one continuous coating is evidenced by a uniform light pink color. Prime inside of potting boot.

(4) Allow primer to dry at room temperature a minimum of one hour. If more than 8 hours elapse, primer must be washed off according to substep 1, and connector and potting boot reprimed.

(5) Slide potting boot into place on connector.

WARNING

The following procedure specifies Thermolite 12, which by itself or when mixed with silicone elastomer compound must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

(6) Mix potting compound as follows:

(a) Mix 100 parts by weight of silicone elastomer compound with 1 ±25 part by weight of Thermolite 12. Mix until a uniform appearance and consistency of mixture is evident.

NOTE

Generally, 2 minutes of mixing is necessary to thoroughly blend a batch of material.

(b) Fill dispenser with mixed potting compound within 3 minutes after initial mixing, taking care to prevent trapping air in compound.

(7) Within 5 minutes after initial mixing, inject compound into one side of area to be potted. Carefully work compound among connector contacts with a wooden spatula being careful not to trap air in compound. Fill plastic potting boot completely.

(8) Allow potting compound to cure at room temperature for a minimum of 12 hours or at 120 ±10° F for a minimum of 3 hours.

(9) Carefully strip any excess potting compound of exterior surfaces by hand or with wood spatula. Do not disturb potting boot or scratch plated, painted, or coated surfaces.

g. Repeat continuity test, step e.

5-8. REPAIRING TRANSDUCER HARNESS.

5-9. Repairing a transducer harness consists of unsoldering the connector, cutting the damaged wire(s) to eliminate the damaged section(s), cutting the remaining wires in the harness to an equivalent length, resoldering and potting the connector. Whether a harness can be repaired depends on the final length of the harness after repair. The harness length after repair must meet the minimum length requirement shown in figure 5-1 to ensure that the harness will not be preloaded in its installed condition. Before repairing a harness, make sure harness, after removing the damaged portion(s), will meet the minimum length requirements. If harness will not meet the minimum length replace the package.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Identify each wire with a piece of tape marked to indicate corresponding pin letter of connector.

c. Cut damaged wire(s) so as to leave damaged section connected to connector. Make sure wire(s) are cut to a length that meets, or is in excess of, minimum repairable wire length shown in figure 5-1.

d. Cut remaining undamaged wires to length of shortest wire.

e. Carefully split and remove potting boot from connector.

f. Carefully remove enough potting compound to expose soldered terminals of connector and to permit unsoldering wires.

g. Unsolder and discard all wires from connector.

h. Resolder connector to harness. (Refer to paragraph 5-7.)

Tap Code	Continuity	
	From	To
PF3	P135 - A	J103 - M
	P135 - B	J103 - f
	P135 - C	J103 - $\overline{Z}$
	P135 - D	J103 - N
	P135 - E	J103 - W
	P135 - F	J103 - X
PO3	P136 - A	J103 - M
	P136 - B	J103 - e
	P136 - C	J103 - $\overline{Z}$
	P136 - D	J103 - N
	P136 - E	J103 - k
	P136 - F	J103 - m
CG1	P137 - A	J103 - M
	P137 - B	J103 - p
	P137 - C	J103 - $\overline{Z}$
	P137 - D	J103 - N
	P137 - E	J103 - g
	P137 - F	J103 - n
GG1 or TG1	P138 - A	J103 - M
	P138 - B	J103 - h
	P138 - C	J103 - $\overline{Z}$
	P138 - D	J103 - N
	P138 - E	J103 - j
	P138 - F	J103 - r
NN1	P139 - A	J103 - M
	P139 - B	J103 - T
	P139 - C	J103 - Z
	P139 - D	J103 - N
	P139 - E	J103 - U
	P139 - F	J103 - V
TF1	P140 - A	J103 - M
	P140 - B	J103 - b
	P140 - C	J103 - $\overline{Z}$
	P140 - D	J103 - N
	P140 - E	J103 - c
	P140 - F	J103 - d

Figure 5-2. Primary Flight Instrumentation Package Transducer Harness Wiring

5-10. PREINSTALLATION TESTING.

5-11. The preinstallation test of the flight instrumentation packages consists of a pressure check. Check pressure as outlined in R-3825-1B, paragraph titled MEASURING PRESSURE IN ELECTRICAL CONTROL ASSEMBLY AND PRIMARY AND AUXILIARY FLIGHT INSTRUMENTATION PACKAGES.

Tap Code	Continuity	
	From	To
GO5	P181 - A	J151 - U
	P181 - B	J151 - h
	P181 - C	J151 - $\overline{T}$
	P181 - D	J151 - c
	P181 - E	J151 - $\overline{Z}$
	P181 - F	J151 - a
GF4	P182 - A	J151 - U
	P182 - B	J151 - s
	P182 - C	J151 - $\overline{T}$
	P182 - D	J151 - c
	P182 - E	J151 - j
	P182 - F	J151 - k
NN2	P183 - A	J150 - A
	P183 - B	J152 - d
	P183 - C	J150 - $\overline{D}$
	P183 - D	J150 - B
	P183 - E	J152 - e
	P183 - F	J152 - $\overline{k}$
CF2	P184 - A	J150 - A
	P184 - B	J152 - V
	P184 - C	J150 - D
	P184 - D	J150 - B
	P184 - E	J152 - W
	P184 - F	J152 - X
PO8	P185 - A	J151 - U
	P185 - B	J151 - V
	P185 - C	J151 - T
	P185 - D	J151 - c
	P185 - E	J151 - $\overline{O}$
	P185 - F	J151 - P
TG4	P186 - A	J150 - A
	P186 - B	J152 - n
	P186 - C	J150 - $\overline{D}$
	P186 - D	J150 - B
	P186 - E	J152 - p
	P186 - F	J152 - r

Tap Code	Continuity	
	From	To
NN1	P187 - A	J151 - U
	P187 - B	J151 - n
	P187 - C	J151 - $\overline{T}$
	P187 - D	J151 - c
	P187 - E	J151 - f
	P187 - F	J151 - g
HO1	P188 - A	J151 - U
	P188 - B	J151 - m
	P188 - C	J151 - $\overline{T}$
	P188 - D	J151 - c
	P188 - E	J151 - d
	P188 - F	J151 - e
PO6	P189 - A	J151 - U
	P189 - B	J151 - v
	P189 - C	J151 - $\overline{T}$
	P189 - D	J151 - c
	P189 - E	J151 - w
	P189 - F	J151 - x
TF1	P190 - A	J151 - U
	P190 - B	J151 - y
	P190 - C	J151 - $\overline{T}$
	P190 - D	J151 - c
	P190 - E	J151 - t
	P190 - F	J151 - u
PO9	P191 - A	J151 - U
	P191 - B	J151 - W
	P191 - C	J151 - T
	P191 - D	J151 - c
	P191 - E	J151 - $\overline{X}$
	P191 - F	J151 - Y
TG3	P192 - A	J150 - A
	P192 - B	J152 - m
	P192 - C	J150 - $\overline{D}$
	P192 - D	J150 - B
	P192 - E	J152 - f
	P192 - F	J152 - $\overline{Z}$

Figure 5-3. Auxiliary Flight Instrumentation Package Transducer Harness Wiring (Sheet 1 of 2)

Tap Code	Continuity		Tap Code	Continuity	
	From	To		From	To
CO3	P193 - A	J150 - A	Dummy	P196 - A	J151 - U
	P193 - B	J152 - a		P196 - B	J151 - L
	P193 - C	J150 - $\overline{D}$		P196 - C	J151 - T
	P193 - D	J150 - B		P196 - D	J151 - c
	P193 - E	J152 - b		P196 - E	J151 - $\overline{Q}$
	P193 - F	J152 - $\overline{c}$		P196 - F	J151 - K
PF5	P194 - A	J150 - A	Dummy	P197 - A	J151 - U
	P194 - B	J152 - $\overline{g}$		P197 - B	J151 - M
	P194 - C	J150 - $\overline{D}$		P197 - C	J151 - T
	P194 - D	J150 - B		P197 - D	J151 - c
	P194 - E	J152 - h		P197 - E	J151 - $\overline{R}$
	P194 - F	J152 - $\overline{j}$		P197 - F	J151 - S
Dummy	P195 - A	J151 - U			
	P195 - B	J151 - J			
	P195 - C	J151 - T			
	P195 - D	J151 - c			
	P195 - E	J151 - $\overline{H}$			
	P195 - F	J151 - C			

Figure 5-3. Auxiliary Flight Instrumentation Package Transducer Harness Wiring (Sheet 2 of 2)

SECTION VI

FUEL TURBOPUMP

6-1. SCOPE. This section contains instructions for removing, inspecting, repairing, and reinstalling parts of fuel turbopumps 460160-61 through -81 and 460390-121 through -201.

6-2. DISASSEMBLY.

6-3. Disassembly of the fuel turbopump is limited to removing parts from the turbine end for necessary repairs and replacements. Procedures for removing parts from fuel turbopumps 460390-191 and -201 are in paragraphs 6-4 through 6-10. Procedures for removing parts from fuel turbopumps 460160-61 through -81 and 460390-121 through -171 are in paragraphs 6-11 through 6-17. If a primary, secondary, or turbine seal must be removed, all of the turbopump seals must be leak checked before removal, and the leakages recorded. (Refer to paragraph 6-40.)

6-4. REMOVING SECOND-STAGE TURBINE WHEEL (FUEL TURBOPUMPS 460390-191 AND -201). The second-stage turbine wheel can be removed, inspected, repaired, and reinstalled. (See figure 6-1 for parts identification.)

a. Obtain the following equipment and materials, or their equivalents:

(1) Fuel turbine torquing wrench kit 9016711-21.

(2) Fuel turbine disk removal guide pin kit 9022277.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove turbine exhaust duct as outlined in R-3825-3, Volume I.

d. Using a torque wrench and wrench 9019861-11 from wrench kit, engage spline of plate (23).

CAUTION

Maximum torque must not exceed 1,000 in-lb, or damage to equipment can result.

e. Rotate turbine wheel counterclockwise and record maximum torque required to initiate rotation (breakaway). Breakaway torque must not exceed 1,000 in-lb.

f. Continue to rotate turbine shaft slowly and record torque required to maintain rotation (running). Running torque must not exceed 300 in-lb.

g. Measure and record axial run-out at the 10.82 ±0.003-inch diameter on the second-stage turbine wheel (22).

h. Index bolts (25) with felt marker pen for reassembly into same holes.

i. Remove 2 diametrically opposed bolts (25). Install guide pins 9022290 from fuel turbine disk removal guide pin kit.

CAUTION

Damage to the stator assembly can result if first-stage turbine wheel is dropped on stator blades. If turbopump is vertical, second-stage turbine wheel must be supported when removing bolts (25).

j. Remove remaining bolts (25), tab (24) or (24A), and plate (23). Discard tab (24) or (24A). If pump is vertical, bolts (25) and second-stage turbine wheel (22) must be removed slowly to allow first-stage turbine wheel (17) to rest on stator assembly (18).

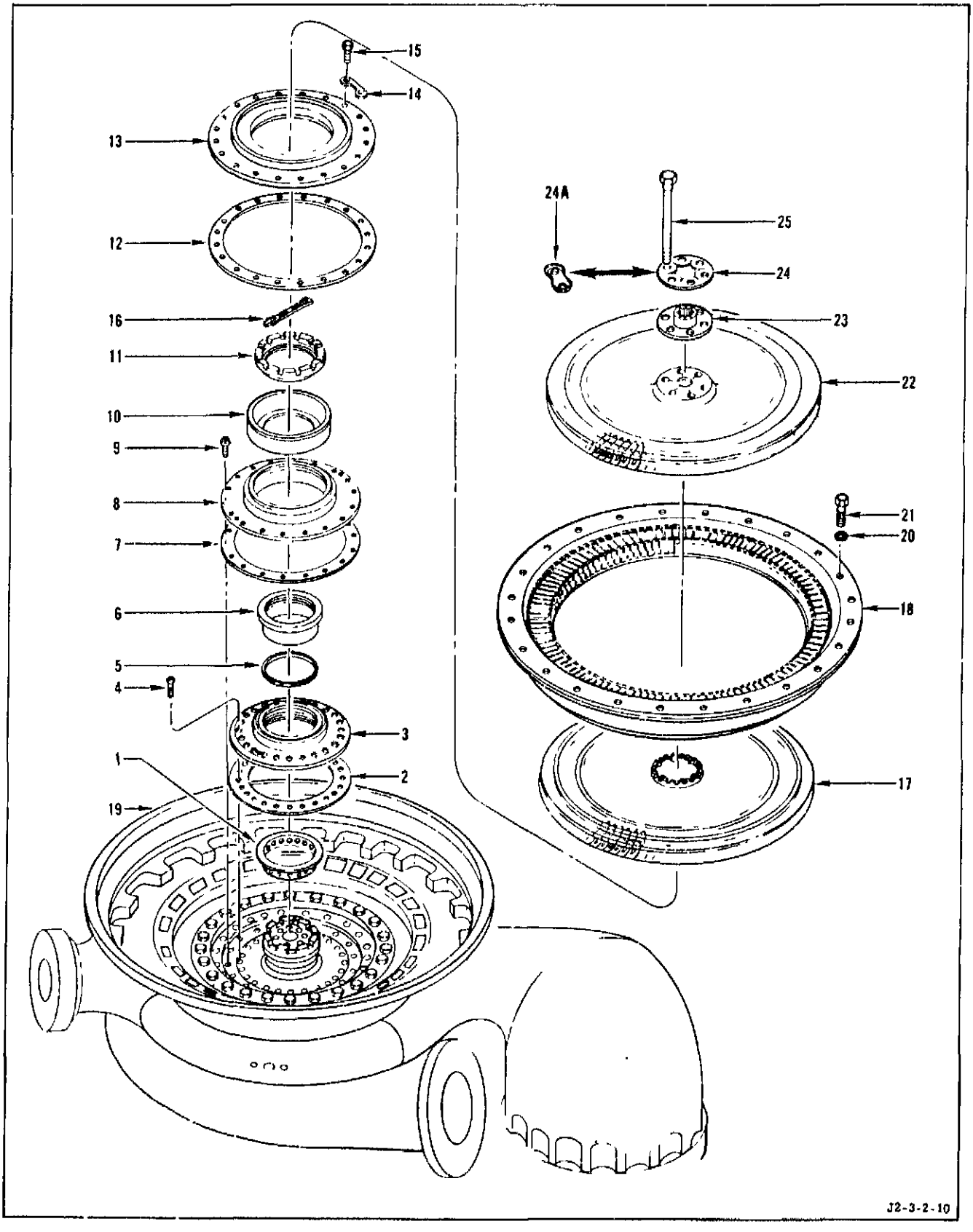


Figure 6-1. Fuel Turbopumps 460390-191 and -201 (Sheet 1 of 2)

Index No.	Nomenclature	Index No.	Nomenclature
1	Primary mating ring	14	Tab
2	Shim	15	Bolt
3	Primary seal	16	Lock
4	Bolt	17	First-stage turbine wheel
5	Omniseal	18	Stator assembly
6	Spacer	19	Manifold
7	Shim	20	Tab
8	Secondary seal	21	Bolt
9	Bolt	22	Second-stage turbine wheel
10	Secondary mating ring	23	Plate
11	Nut	24	Tab
12	Gasket	24A	Tab (alternate)
13	Turbine seal	25	Bolt

Figure 6-1. Fuel Turbopumps 460390-191 and -201 (Sheet 2 of 2)

k. Insert ball-lock pins SL-19212, from fuel turbine disk removal guide pin kit into diametrically opposed boltholes of second-stage turbine wheel (22). Note alinement of B-balance matchmarks at curvic interface to first-stage turbine wheel (17) to aid during assembling (figure 6-2).

l. If second-stage turbine wheel (22) does not separate from first-stage turbine wheel (17) do the following:

(1) Index-mark stator assembly (18) to manifold (19), to aid in reassembly.

(2) Remove bolts (21) and tabs (20) holding stator assembly (18) to manifold (19), making sure to support turbine wheels and stator assembly.

(3) Remove second-stage turbine wheel (22), stator assembly (18), and first-stage turbine wheel (17) as an assembly.

(4) Place first-stage turbine wheel (17) downward on flat surface and support wheel so curvics do not contact flat surface.

(5) Using a nonmetallic mallet, tap periphery of second-stage turbine wheel, inboard of blades, or apply dry ice to mating curvic area of one wheel only, so that wheels will separate.

m. Inspect second-stage turbine wheel (22) as outlined in paragraph 6-20.

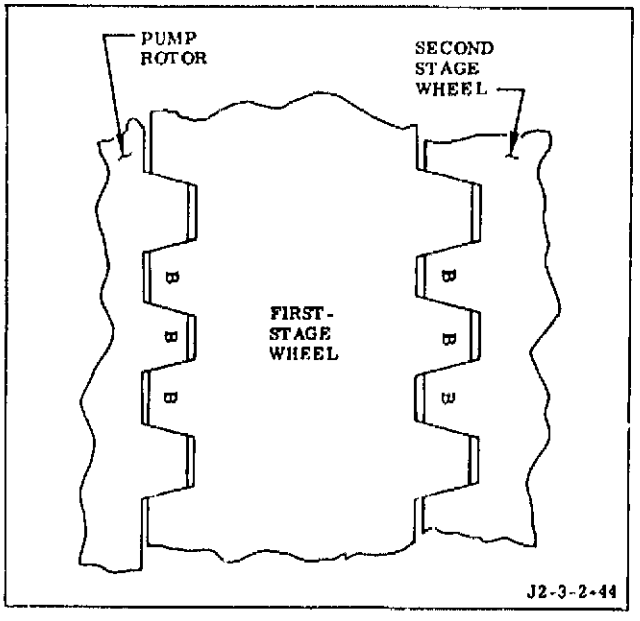


Figure 6-2. Alinement of B Balance Matchmarks at Curvic Interfaces

6-5. REMOVING FIRST-STAGE TURBINE WHEEL (FUEL TURBOPUMPS 460390-191 AND -201). The first-stage turbine wheel can be removed, inspected, repaired, and reinstalled. See figure 6-1 for parts identification.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Perform paragraph 6-4.

c. If second-stage turbine wheel (22) does separate from first-stage turbine wheel (17) do the following.

(1) Index-mark stator assembly (18) to manifold (19), to aid in reassembly.

(2) Remove bolts (21) and tabs (20) holding stator assembly (18) to manifold (19). Remove stator assembly (18) and discard tabs (20). If pump is vertical, remove first-stage turbine wheel (17) with stator assembly (18).

d. Note alinement of B-balance matchmarks at curvic interface to pump rotor, to aid in reassembly (figure 6-2). If pump is not vertical, use ball-lock pins and remove first-stage turbine wheel (17).

e. Remove guide pins from pump shaft.

f. Inspect and repair first-stage turbine wheel (17) as necessary as outlined in paragraph 6-20.

6-6. REMOVING FIRST- AND SECOND-STAGE TURBINE SEALS (HONEYCOMB) (FUEL TURBOPUMPS 460390-191 AND -201). The first-stage turbine seal (honeycomb) can be removed, inspected, repaired, and reinstalled. It cannot be replaced without Rocketdyne engineering evaluation and NASA EPO approval. The second-stage turbine seal can be removed, inspected, repaired, and reinstalled or replaced. (See figure 6-1 for parts identification.)

a. Obtain the following equipment and materials, or their equivalents:

(1) Fuel turbopump curvic shaft wrench kit 9022284-21.

(2) Fuel turbine stationary blade stacking fixture kit 9022276.

(3) Drum sander with No. 80 grit or finer sandpaper. (Required only if radial clearance between first stage turbine wheel and honeycomb seal is insufficient.)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Perform paragraphs 6-4 and 6-5.

d. Remove lock (16).

CAUTION

Bolts RD111-3003-7537 from turbopump shaft curvic wrench kit must not be used, since they are too long and will bottom out when installed.

e. Install shaft curvic coupling wrench 9022306-3 from fuel turbopump shaft curvic wrench kit with bolts RD111-3003-7513. Torque bolts to 25-35 in-lb.

f. Using a torque wrench connected to curvic coupling wrench 9022306-3, rotate pump shaft counterclockwise (viewed from aft end of engine). Record breakaway and running torque.

g. If the first- or second-stage turbine seals (honeycomb) or turbine stator blades are to be removed (figure 6-3), remove bolts securing stator assembly. Separate ring, first-stage turbine seal (honeycomb), turbine stator blades, second-stage turbine seal (honeycomb), and retainer.

h. Inspect first- and second- stage turbine seals (honeycomb) as outlined in paragraph 6-21.

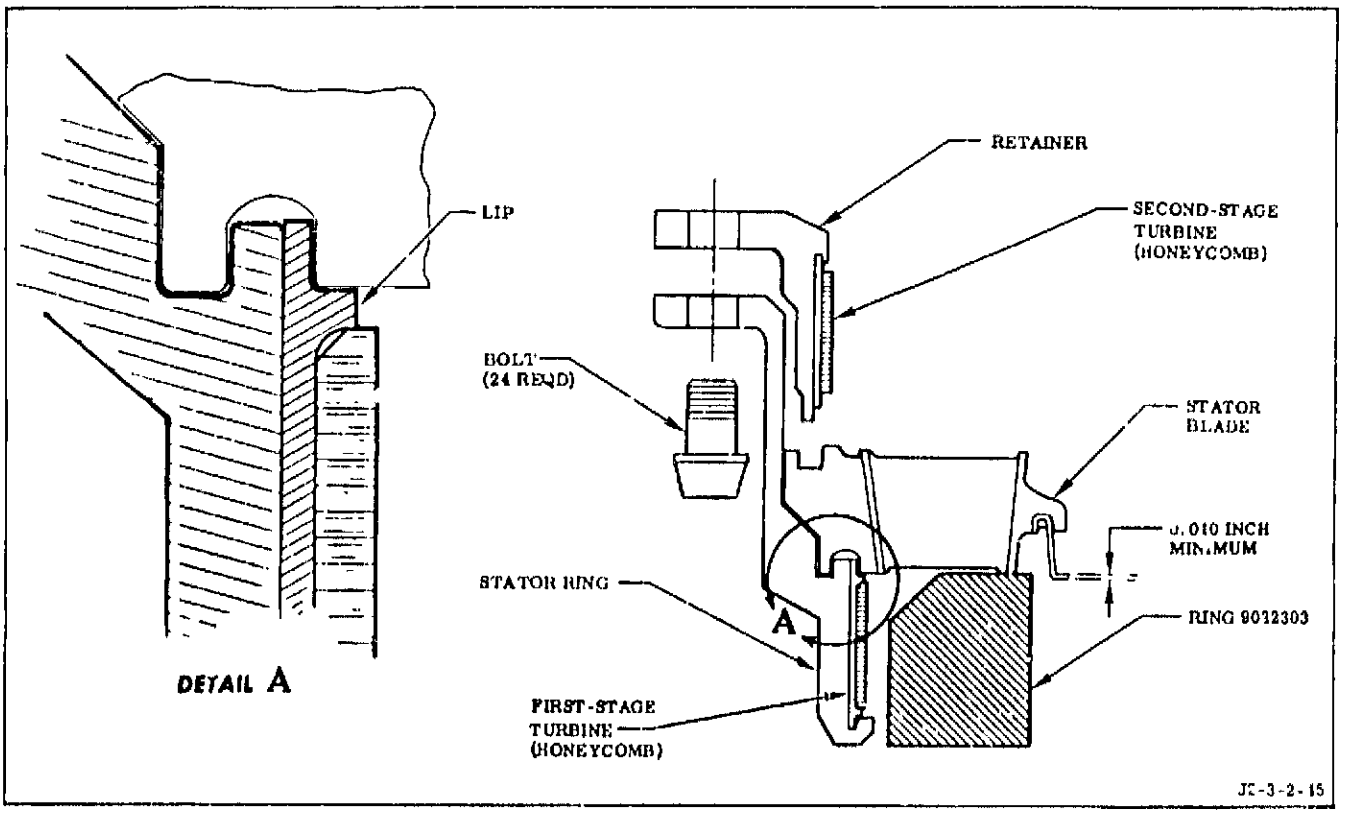


Figure 6-3. Assembling Stator Assembly

CAUTION

If the new first-stage turbine seal (honeycomb) has a lip in the backing band adjacent to the honeycomb, the seal must be installed so that the lip is adjacent to the stator blades (figure 6-3).

i. Assemble stator assembly (figure 6-3), using new first- and second- stage turbine seals (honeycomb) as necessary.

(1) Place support ring 9022303, from fuel turbine stationary blade stacking fixture kit on a flat work surface.

(2) Install first-stage turbine seal (honeycomb) into stator ring.

(3) Center stator ring around support ring.

(4) Assemble stator blades into stator ring.

(5) Install second-stage turbine seal (honeycomb) and retainer.

(6) Secure stator assembly with bolts (figure 6-3) and torque bolts to 20-24 in-lb.

h. After installing new seal, check clearance between inside diameter of honeycomb seal and outside diameter of wheel seal lands as follows (figure 6-4):

(1) Place stator assembly on flat horizontal surface with first-stage turbine seal (honeycomb) end up.

(2) Position first-stage turbine wheel in stator assembly so that wheel is supported by stator blades. If average radial clearance is less than 0.010 inch, machine inside diameter of honeycomb seal using drum sander on a drill press, to obtain an average radial clearance of 0.010 to 0.015 inch.

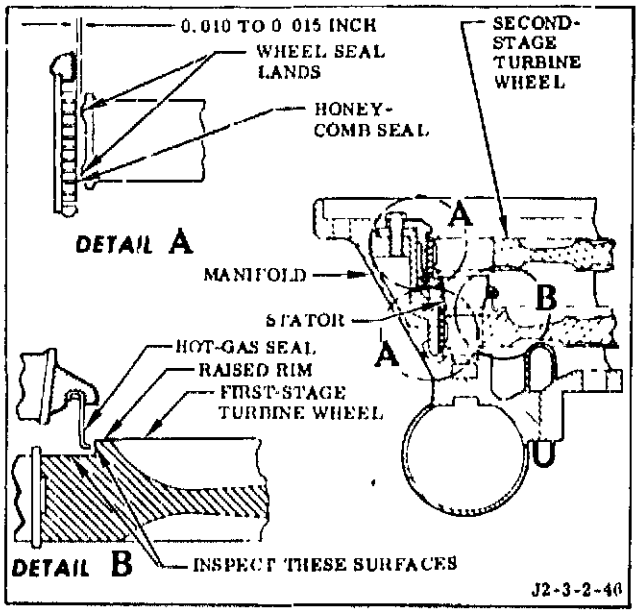


Figure 6-4. Inspection of First-Stage Turbine Wheel

(3) Reverse position of stator assembly and, using second-stage turbine wheel, repeat clearance check for new second-stage turbine seal (honeycomb).

6-7. REMOVING TURBINE SEAL (FUEL TURBOPUMPS 460390-191 AND -201). The turbine seal may be removed and a new seal installed. When the seal is replaced the secondary mating ring must also be replaced. (See figure 6-1 for parts identification.)

a. Obtain a fuel turbopump seal nut spanner wrench kit 9022287.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-5, Volume I.

c. Perform paragraphs 6-4 through 6-6.

d. Remove bolts (15), tabs (14), and remove turbine seal (13) and gasket (12). Discard tabs (14).

e. Measure and record dimensions A and B as shown in figure 6-12.

f. Assemble turbine seal nut spanner wrench 9022307 and retainer 9022308 from fuel turbopump seal nut spanner wrench kit. Adjust wrench 9022307 and retainer 9022308 until wrench engages nut (11) and retainer mates with manifold (19) flange (figure 6-5). (Nut has left-hand threads.)

NOTE

Nut (11), retainer 9022308, and wrench 9022307 have the same thread pitch. The nut and wrench back out at the same rate.

g. Attach retainer 9022308 to flange with 2 bolts AN4-6. Torque bolts to 25-35 in-lb.

h. Hold pump shaft with curvic coupling wrench and remove nut (11). (Nut has lefthand threads.)

i. Remove secondary mating ring (10).

6-8. REMOVING SECONDARY SEAL (FUEL TURBOPUMPS 460390-191 AND -201). The secondary seal may be removed and a new seal installed. When the seal is replaced the secondary mating ring must also be replaced. (See figure 6-1 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Perform paragraphs 6-4 through 6-7.

CAUTION

Extreme care must be used when handling seals and mating rings to prevent damage.

c. Remove bolts (9) and remove secondary seal (8) and shim (7).

6-9. REMOVING OMNISEAL (FUEL TURBOPUMPS 460390-191 AND -201). The omniseal may be removed, inspected, and reinstalled or replaced. (See figure 6-1 for parts identification.)

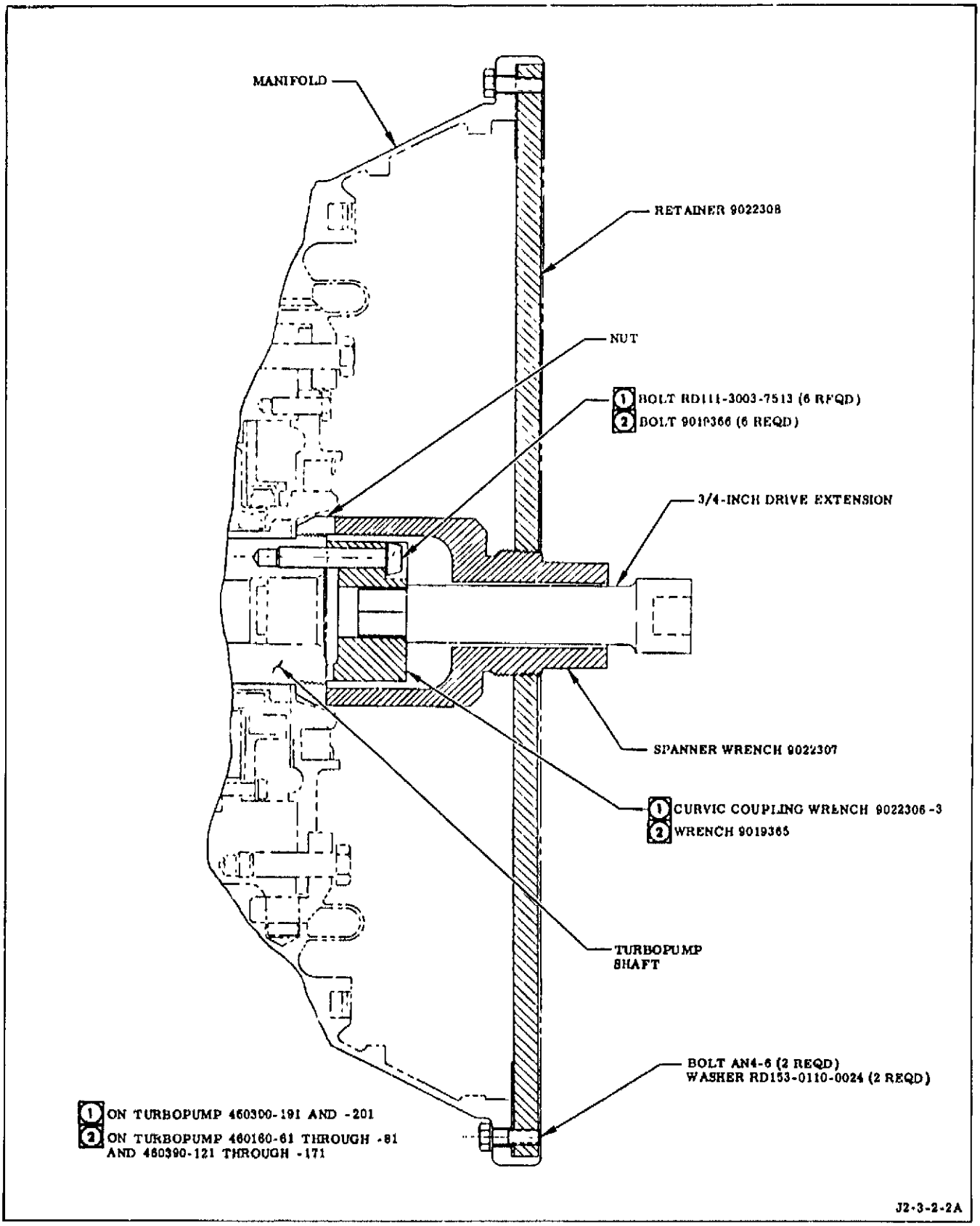


Figure 6-5. Removing Nut from Turbopump Shaft

a. Obtain a fuel turbopump spacer and mating ring seal puller kit 9022286-11.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Perform paragraphs 6-4 through 6-8.

d. Using spacer puller adapters 9025394, and spacer and mating ring seal puller assembly 9022309 from fuel turbopump spacer and mating ring seal puller kit, remove spacer (6) as follows:

(1) Place 2 adapters 9025394 over spacer (6) with larger inside diameter of adapters toward pump shaft.

(2) Loosen clamp and back out bolt on puller 9022309. Place puller over adapters and tighten puller clamp to retain adapters on spacer. Do not overtighten clamp.

NOTE

It may be necessary to replace puller clamp spacer with a shorter one to firmly grip adapters.

(3) Tighten bolt on puller 9022309 to remove spacer (6) from pump shaft.

(4) Loosen clamp on puller and remove puller 9022309 and spacer puller adapters 9025394 from spacer (6).

e. Visually inspect omniseal (5) for damage while seal is installed in spacer (6). If no damage is found and seal leakage was not excessive, do not remove omniseal from spacer. If excessive omniseal leakage was detected before disassembly or if inspection reveals damaged seal, remove omniseal (5) from spacer (6) and discard omniseal.

6-10. REMOVING PRIMARY SEAL (FUEL TURBOPUMPS 460390-191 AND -201). The primary seal can be removed and a new seal installed. When the seal is replaced the primary mating ring must be replaced also. (See figure 6-1 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Perform paragraphs 6-4 through 6-9.

CAUTION

Disturbing bearing retainer nut affects the balance piston setting and can damage the turbopump.

c. Remove primary seal (3) and shim (2). Discard bolts (4). Do not disturb bearing retainer nut.

d. Loosen clamp, back out bolt, place puller 9022309 over primary mating ring (1), and tighten puller clamp. Do not overtighten clamp. Remove ring (1).

6-11. REMOVING SECOND-STAGE TURBINE WHEEL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). The second-stage turbine wheel can be removed, inspected, repaired, and reinstalled. (See figure 6-6 for parts identification.)

a. Obtain the following equipment and material, or their equivalents:

(1) Fuel turbine torquing wrench kit 9016711-21.

(2) Trichloroethylene RB0210-003 (Rocketdyne).

(3) Stud torque wrench 9021821 or T-5033142.

(4) Fuel turbopump turbine wheel removal tool kit 9019356.

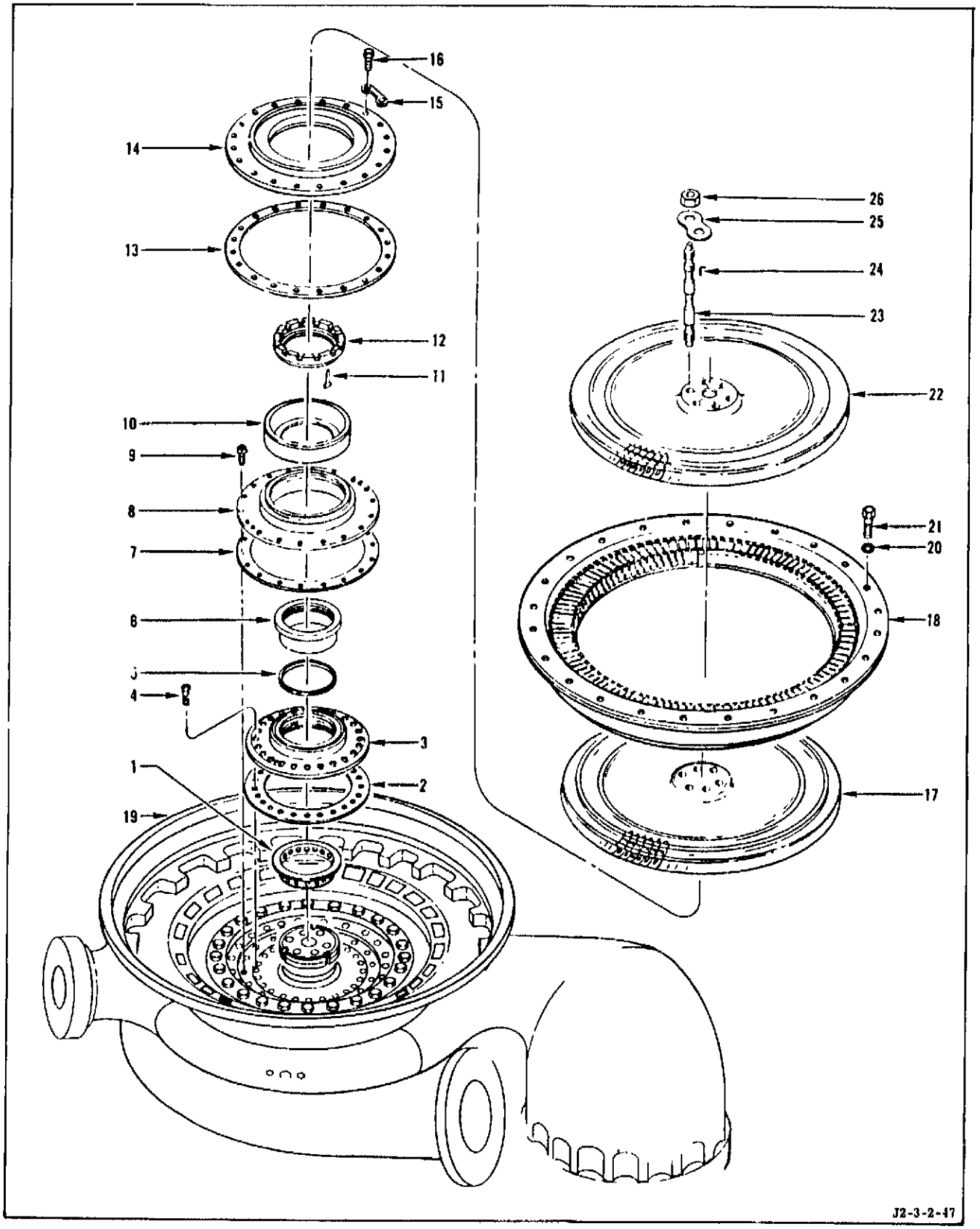


Figure 6-6. Fuel Turbopumps 460160-61 Through -81 and 460390-121 Through -171 (Sheet 1 of 2)

Index No.	Nomenclature	Index No.	Nomenclature
1	Primary seal mating ring	14	Turbine seal
2	Shim	15	Tab
3	Primary seal	16	Bolt
4	Bolt	17	First-stage turbine wheel
5	Omni seal	18	Stator assembly
6	Spacer	19	Manifold
7	Shim	20	Tab
8	Secondary seal	21	Bolt
9	Bolt	22	Second-stage turbine wheel
10	Secondary/turbine seal mating ring	23	Stud
		24	Stud Lock
11	Lock	25	Lock Tab
12	Nut	26	Nut
13	Gasket		

Figure 6-6. Fuel Turbopumps 460160-61 Through -81 and 460390-121 Through -171 (Sheet 2 of 2)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove turbine exhaust duct as outlined in R-3825-3, Volume I.

d. Using torque wrench and adapter 19-9025816 from fuel turbine torquing wrench kit, engage hex on second-stage turbine wheel.

CAUTION

Maximum torque must not exceed 1,000 in-lb, or damage to equipment can result.

e. Rotate turbine wheel counterclockwise and record maximum torque required to initiate rotation (breakaway). Breakaway torque must not exceed 1,000 in-lb.

f. Continue to rotate turbine shaft slowly and record torque required to maintain rotation (running). Running torque must not exceed 300 in-lb.

g. Measure and record axial runout at a 10.82 ±0.003-inch diameter on second-stage turbine wheel.

h. Measure and record actual dimension A (figure 6-7) from turbine exhaust flange to second-stage turbine wheel at the 10.82 ±0.003-inch diameter.

CAUTION

Studs (23) must not be removed until after the turbine wheels are removed, or damage to turbine wheel can result.

i. Identify studs (23) with associated turbine wheel stud bore, to aid in reassembly. Do not impression stamp.

j. Apply trichloroethylene RB0210-003 (Rocketdyne) to studs (23) and nuts (26).

CAUTION

If the turbopump is oriented with the turbine end facing downward, the wheel must be supported at all times, or the wheel can drop free.

k. Using stud torque wrench 9021821 or T-5033142-201, remove nuts (26). Do not permit studs to turn, and do not exceed 200 in-lb of torque on stud square head at any time.

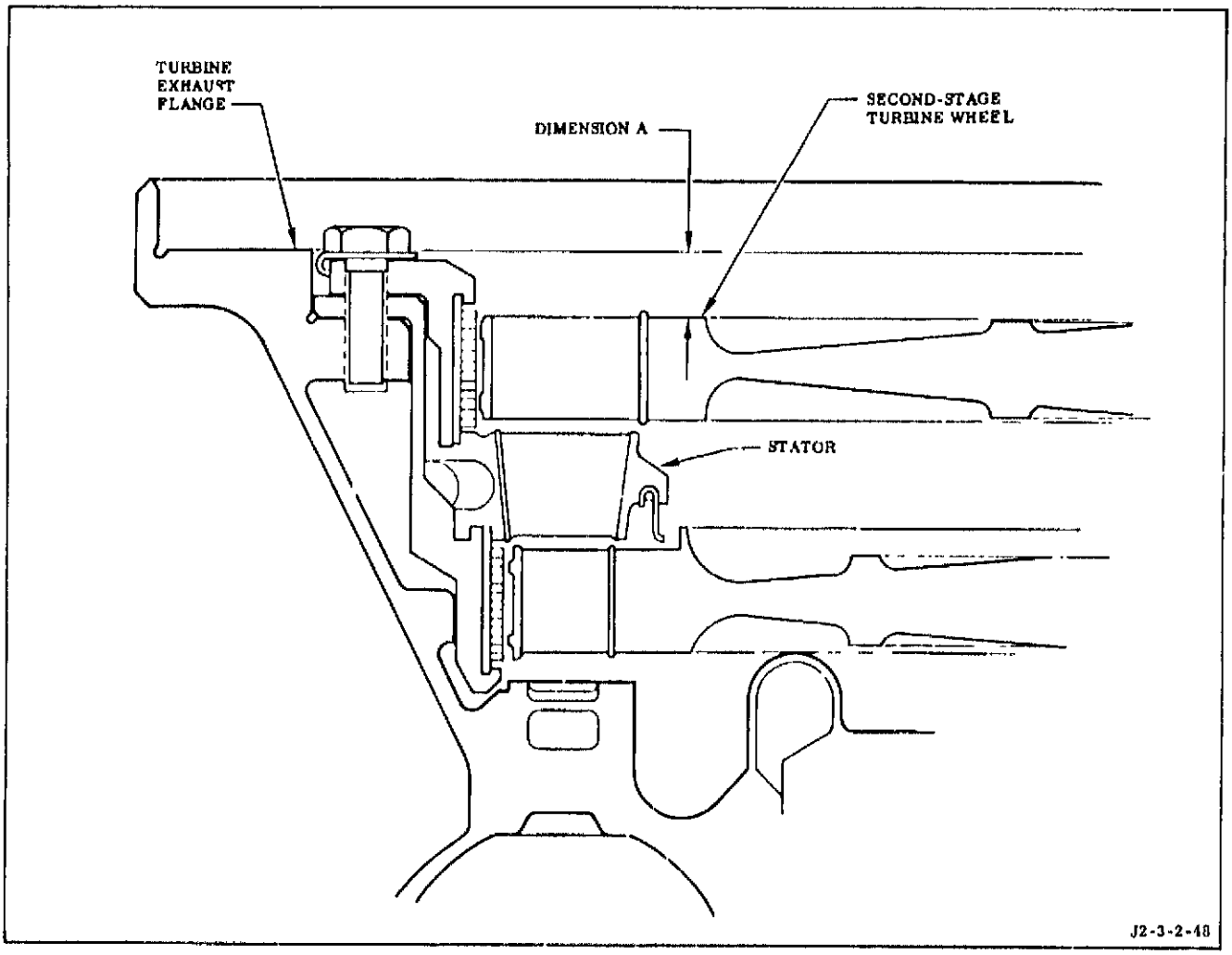


Figure 6-7. Determining Measurement From Manifold to Second-Stage Turbine Wheel

l. Remove and discard lock tabs (25).

m. Remove stud locks (24).

n. If turbopump is vertical (turbine end downward), slowly remove second-stage turbine wheel, allowing first-stage turbine wheel to rest on stator assembly. If turbopump is other than vertical (turbine end downward), using adapter 9019357 and puller assembly 9019358 from fuel turbopump wheel removal tool kit, remove second-stage turbine wheel as follows:

(1) With screw backed out so that pusher clears studs (23), place puller assembly against wheel-puller flange of turbine wheel.

(2) Position both halves of adapter 9019357 simultaneously around wheel-puller flange and spreader ring. Secure adapter halves together with 2 screws NAS1351-4-16. Torque screws to 23-29 in-lb.

(3) Rotate puller assembly knob clockwise until pusher contacts studs; continue rotating knob until wheel contacts pusher. Move turbine wheel and puller assembly until wheel clears studs.

(4) Remove puller assembly.

m. Inspect second-stage turbine wheel (22) as outlined in paragraph 6-20.

6-12. REMOVING FIRST-STAGE TURBINE WHEEL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). The first-stage turbine wheel can be removed, inspected, repaired, and reinstalled. (See figure 6-6 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Perform paragraph 6-11.

c. Index mark stator assembly (18) to manifold (19), to aid in reassembly.

d. If turbopump is vertical (turbine end downward), support stator assembly and first-stage turbine wheel, remove bolts (21) and tabs (20); then remove stator assembly and first-stage turbine wheel together. Discard tabs (20). If turbopump is other than vertical (turbine end downward), remove bolts (21) and tabs (20), remove stator assembly; then remove first-stage turbine wheel as follows:

(1) With screw backed out so that pusher clears studs (23), place puller assembly against wheel-puller flange of turbine wheel.

(2) Position both halves of adapter 9019357 simultaneously around wheel-puller flange and spreader ring. Secure adapter halves together with 2 screws NAS1351-4-16. Torque screws to 23-29 in-lb.

(3) Rotate puller assembly knob clockwise until pusher contacts studs; continue rotating knob until wheel contacts pusher. Move turbine wheel and puller assembly until wheel clears studs.

(4) Remove puller assembly.

e. Inspect and repair first-stage turbine wheel (17) as necessary as outlined in paragraph 6-20.

6-13. REMOVING FIRST- AND SECOND-STAGE TURBINE SEALS (HONEYCOMB) (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). The first-stage turbine seal (honeycomb) can be removed, inspected, repaired, and reinstalled. It cannot be replaced without Rocketdyne engineering evaluation and NASA EPO approval. The second-stage turbine seal (honeycomb) can be removed, inspected, repaired, and reinstalled or replaced. (See figure 6-6 for parts identification.)

a. Obtain the following equipment and material, or their equivalents:

(1) Fuel turbopump curvic shaft wrench kit 9022284-21.

(2) Fuel turbine stationary blade stacking fixture kit 9022276.

(3) Drum sander with No. 80 grit or finer sandpaper. (Required only if radial clearance between first stage turbine wheel and honeycomb seal is insufficient.)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Perform paragraphs 6-11 and 6-12.

d. Index mark individual studs (23) to rotor to aid during reassembly; then remove studs (23). Do not impression stamp.

e. Unlock locks (11).

f. Install shaft coupling wrench 9019365 from fuel turbopump shaft curvic wrench kit with bolts 9019366 (figure 6-5). Torque bolts to 60 ±15 in-lb.

g. Using a torque wrench connected to wrench 9019365, rotate pump shaft counterclockwise. Record breakaway and running torque.

h. If first- or second-stage turbine seal (honeycomb) or stator blades are being replaced (figure 6-3), remove bolts and washers securing stator assembly; then separate ring, first-stage turbine seal (honeycomb), stator blades, second-stage turbine seal (honeycomb), and retainer.

i. Assemble stator assembly (figure 6-3), using new honeycomb seal as necessary.

(1) Place support ring 9022303, from fuel turbine stationary blade stacking fixture kit on a flat work surface.

(2) Install first-stage turbine seal (honeycomb), with lip adjacent to stator blades, into stator ring.

(3) Center stator ring around support ring.

(4) Assemble stator blades into stator ring.

(5) Install second-stage turbine seal (honeycomb) and retainer.

(6) Secure assembly with bolts (figure 6-3) and torque bolts to 20-24 in-lb.

j. After installing new honeycomb seal, check clearance between inside diameter of honeycomb seal and outside diameter of wheel seal lands as follows (figure 6-4):

(1) Place stator assembly on flat horizontal surface with first-stage honeycomb seal end up. Position first-stage wheel in stator assembly so that it is supported by stator blades. If average radial clearance is less than 0.010 inch, machine inside diameter of honeycomb seal using drum sander on a drill press, to obtain an average radial clearance of 0.010 to 0.015 inch.

(2) Reverse position of stator assembly and, using second-stage turbine wheel, repeat clearance check for new second-stage turbine seal (honeycomb).

6-14. REMOVING TURBINE SEAL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). The turbine seal may be removed and a new seal installed. When the seal is replaced the secondary mating seal must also be replaced. (See figure 6-6 for parts identification.)

a. Obtain a fuel turbopump seal nut spanner wrench kit 9022287.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Perform paragraphs 6-11 through 6-13.

d. Remove bolts (16), tabs (15), and remove turbine seal (14) and gasket (13). Discard tabs (15).

e. Measure and record dimensions A and B as shown in figure 6-12.

f. See figure 6-5 and assemble turbine seal nut spanner wrench 9022307 and retainer 9022308 from fuel turbopump seal nut spanner wrench kit. Adjust wrench 9022307 and retainer 9022308 until wrench engages nut (12) and retainer mates with manifold (19) flange. (Nut has left-hand threads.)

NOTE

Nut (12), retainer 9022308, and wrench 9022307 have the same thread pitch. The nut and wrench back out at the same rate.

g. Attach retainer 9022308 o flange with 2 bolts AN4-6. Torque bolts to 25-35 in-lb.

h. Hold pump shaft with wrench 9010365 and remove nut (12). (Nut has left-hand threads.) Remove and discard locks (11).

CAUTION

Extreme care must be used when handling mating ring to prevent damage.

i. Remove secondary mating ring (10).

6-15. REMOVING SECONDARY SEAL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). The secondary seal may be removed and a new seal installed. When the seal is replaced the secondary mating ring must also be replaced. (See figure 6-6 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Perform paragraph 6-11 through 6-14.

CAUTION

Extreme care must be used when handling seals and mating rings to prevent damage.

c. Remove bolts (9) and remove secondary seal (8) and shim (7).

6-16. REMOVING OMNISEAL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). The omniseal may be removed, inspected, and reinstalled or replaced. (See figure 6-6 for parts identification.)

a. Obtain a fuel turbopump spacer and mating ring seal puller kit 9022286-11.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Perform paragraphs 6-11 through 6-15.

d. Using spacer puller adapters 9025394, and spacer and mating ring seal puller assembly 9022309 from fuel turbopump spacer and mating ring seal puller kit, remove spacer as follows:

(1) Place 2 adapters 9025394 over spacer (6) with larger inside diameter of adapters toward pump shaft.

(2) Loosen clamp and back out bolt on puller 9022309-11. Place puller over adapters and tighten puller clamp to retain adapters on spacer. Do not overtighten clamp.

NOTE

It may be necessary to replace puller clamp spacer with a shorter one to firmly grip adapters.

(3) Tighten bolt on puller 9022309-11 to remove spacer (6) from pump shaft.

(4) Loosen clamp on puller, and remove puller 9022309-11 and spacer puller adapters 9025394 from spacer (6).

e. Visually inspect omniseal (5) for damage while seal is still installed in spacer (6). If no damage is found and seal leakage was not excessive before pump disassembly, do not remove omniseal from spacer. If excessive omniseal leakage was noted before disassembly and/or if inspection revealed damaged seal, remove omniseal (5) from spacer (6) and discard seal.

6-17. REMOVING PRIMARY SEAL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). The primary seal may be removed and a new seal installed. When the seal is replaced the primary mating ring must be replaced also. (See figure 6-6 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Perform paragraphs 6-11 through 6-16.

CAUTION

Disturbing bearing seal retainer nut affects the balance piston setting and can damage the turbopump.

c. Remove bolts (4) and remove primary seal (3) and shim (2). Discard bolts (4). Do not disturb bearing retainer nut.

d. Loosen clamp, back out bolt, place puller 9022309-11 over primary seal mating ring (1), and tighten puller clamp. Do not overtighten clamp. Remove ring.

6-18. CLEANING.

6-19. Components of fuel turbopump must be handwiped with trichloroethylene. Refer to R-3825-3, Volume I for cleaning metallic parts. Do not allow solvent to contact carbon seals.

(See figures 6-1 and 6-6 for location and identification of parts.)

6-20. INSPECTING AND REPAIRING.

6-21. The parts of the fuel turbopump listed in figure 6-8 must be inspected and repaired as indicated. Since only special features and repairs are included in this figure, the parts not listed must be visually inspected and repaired or replaced as necessary.

Part Name and Index Number (See figures 6-1 and 6-6.)	Inspection	Disposition
First- and second-stage turbine wheels (17, 22)	Visually inspect first-stage wheel for grooves caused by turbine stator blade seals (figure 6-4).	First-stage turbine wheel with grooves less than 0.005 inch deep are acceptable for reuse after removing any deposited seal material and polishing to remove any raised material.
	Visually inspect turbine wheel blades for cracks or damage.	If any visible cracks or damage exist, notify Rocketdyne Representative.
	Dye-penetrant inspect turbine wheel disks and curvics.	Any cracks are cause for rejection.
Stator assembly (18)	Visually inspect hot-gas seals for reduction of seal thickness due to rubbing with first-stage wheel (figure 6-4).	Hot-gas seals with a thickness of 0.010 inch or greater are acceptable. If thickness is less than 0.010 inch, notify Rocketdyne Representative.
	Visually inspect stator blades for cracks or damage.	If any visible cracks or damage exist, notify Rocketdyne Representative.
Honeycomb seals	Visually inspect honeycomb seals installed in stator assembly for cracks in backing bands.	If any visible cracks exist, replace honeycomb seal.
	Visually inspect honeycomb seals for missing cells.	Honeycomb seals are acceptable if the sum of all the areas of missing cells does not exceed 0.125 square inch.

Figure 6-8. Inspection and Repair of Fuel Turbopump (Sheet 1 of 2)

Part Name and Index Number (See figures 6-1 and 6-6.)	Inspection	Disposition
Studs (23) (On fuel turbopump 460160-61 through -81 only.)	Visually inspect for cracks.	If any visible cracks exist, replace studs.
Insulated volute cover	Visually inspect cover for depressions, dents, gouges, and creases.	Depression, dents, gouges, and creases are acceptable if they do not puncture insulation cover.
	Visually inspect cover for cracks or punctures.	If any cracks or punctures exist, notify Rocketdyne Representative.
Insulated volute cover seal potting	Visually inspect volute cover seal potting for cracks or peeling.	If any cracks or peeling exist, repair potting. (Refer to paragraph 6-23.)
Pump rotor shaft	Visually inspect for surface scoring as a result of removing the primary seal mating ring and shaft spacer.	If there is any scoring in the area of the omniseal sealing surface, contact the Rocketdyne Representative for disposition.

Figure 6-8. Inspection and Repair of Fuel Turbopump (Sheet 2 of 2)

6-22. REPAIRING POTTING USED TO SEAL VOLUTE INSULATION COVER. Cracked or peeling potting compound, which seals the fuel turbopump volute cover, may be repaired as follows:

WARNING

The following procedure specifies acetone, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

a. Obtain the following materials and equipment, or their equivalents:

(1) Primer PR-1531 (Products Research and Chemical, Semco)

(2) Potting compound PR-1532 (Products Research and Chemical, Semco)

(3) Acetone (Federal Specification O-A-51)

(4) Cleaning compound (MIL-C-81302)

(5) Sealant pressure gun, Model 250 (Pyles Industries)

(6) Cartridge No. 250-C6 (Pyles Industries)

(7) Nozzle No. 250N-4-2, 1/8 inch orifice (Pyles Industries)

(8) 240-grit sandpaper

(9) Clean cotton cloths

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Prepare area to be repaired as follows:

(1) If only light cracking or superficial damage has occurred, prepare area as follows:

(a) Clean area to be repaired by handwiping with clean, lint-free cloth dampened with acetone or cleaning compound.

(b) Remove oxidizer surface of potting compound by sanding.

(c) Remove residue from sanding operation by handwiping area with clean, lint-free cloth dampened with acetone or cleaning compound.

WARNING

The following procedure specifies primer PR-1531, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

(2) If severe cracking, peeling, or loss of potting compound material has occurred, prepare area as follows:

(a) Remove as much old potting compound as possible by peeling or scraping away. Potting that is well bonded to the metal and adheres tightly may be left in place.

(b) Remove oxidized surface of any remaining potting compound (substep a) by sanding.

(c) Thoroughly clean metal bonding areas to be primed by handwiping with clean, lint-free cloth dampened with acetone or cleaning compound.

(d) Thoroughly shake primer PR-1531 and apply to area to be primed with a soft-bristled brush. Apply primer in one thin, continuous coat. Allow primer to air dry at room temperature for 40 minutes. Primed surfaces must be potted within 24 hours after priming.

WARNING

The following procedure specifies potting compound PR-1532, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

d. Prepare potting compound for use as follows:

(1) If preweighed potting compound kits are used, proceed as follows:

(a) Mix entire contents of both containers.

(b) Add catalyst to resin.

(c) Mix thoroughly by hand to make sure of adequate dispersion and mixing of components. (Pot life is 4 hours.)

(2) If bulk potting compound is used, weigh and mix components as follows:

(a) To 100 parts by weight of resin (part B, white) add 50 parts by weight of catalyst (part A, grey).

(b) Mix thoroughly by hand until colors have blended. (Pot life is 4 hours.)

(3) If sealant gun is to be used, load mixed potting compound into sealant gun as follows:

(a) Thread nozzle into cartridge.

(b) Fill cartridge with potting compound to within one inch of its open plunger end.

(c) Insert plunger into end of cartridge.

(d) Fasten loaded cartridge into sealant gun.

e. Apply potting compound as follows:

(1) If sealant gun is to be used, apply potting compound as follows:

(a) Place tip of sealant gun nozzle at bottom of cavity to be filled.

(b) Withdraw tip of nozzle, as compound level rises, keeping tip just below surface of compound.

(c) After filling cavity, compound may be smoothed with a spatula to any contour desired.

(2) Instead of sealant gun, potting compound may be applied with a clean spatula, being careful not to trap air bubbles or smear potting compound into adjacent parts or areas.

(3) Before curing, remove any potting compound that has been smeared on adjacent areas by cleaning with a rag dampened with acetone or cleaning compound.

f. Cure potting compound as follows:

(1) Potting compound will appear cured at room temperature within 3 days and will be fully cured within 8 days.

(2) Potting compound may be cured at 120° F for 16 hours, as an alternate to room temperature cure.

(3) Potting compound must not be tacky after curing time has elapsed. If potting is tacky, additional heat may cure material. If additional heat does not cure potting compound, compound must be replaced. Uncured compound can be removed by either scraping off with putty knife or wiping off with cloth dampened with acetone or cleaning compound. All tacky material must be removed before new material is applied.

6-23. ASSEMBLY.

6-24. When replacement of the primary, secondary, or turbine seal is necessary, the corresponding mating ring must also be replaced. Acceptable seals removed for access only may be reinstalled whether using the same or a new mating ring. If the newly installed seal exceeds the specified leakage rate (paragraph 6-39), subsequent seal replacement does not require replacement of the mating ring if no damage is visible. Install parts in fuel turbopumps 460390-191 and -201 as outlined in paragraphs 6-25 through 6-31. Install parts in fuel turbopumps 460160-61 through -81 and 460390-121 through -171 as outlined in paragraphs 6-32 through 6-38.

6-25. INSTALLING SECOND-STAGE TURBINE WHEEL (FUEL TURBOPUMPS 460390-191 AND -201). If stator assembly (18) and first-stage turbine wheel (17) have been removed with the second-stage turbine wheel, install parts as outlined in paragraph 6-26. (See figure 6-1 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

CAUTION

Raised rim at base of blade slots on first-stage turbine wheel must be visible or damage to turbopump can result (figure 6-9).

b. With disk removal guide pins 9022290 installed and using lockpins SL-19212, install second-stage turbine wheel (22), and aline B balance matchmarks (figure 6-3). Make sure rim at base of blade slots on first-stage turbine wheel is visible as shown in figure 6-9.

c. Install plate (23) and aline index marks.

d. Install lock tab (24) or (25).

e. Install 4 bolts (26) as indexed during removal. Do not torque at this time.

f. Remove disk removal guide pins 9022290 and install remaining bolts (26). Torque bolts (26) in sequence 1, 4, 2, 5, 3, 6 in 50 in-lb increments to 455 ±10 in-lb.

g. Bend tab (24) or (25) to secure bolts (26).

h. Measure axial runout at a 10.82 ±0.03-inch diameter on second-stage turbine wheel. Runout must not exceed 0.005 inch total indicated reading.

i. Measure and record turbopump shaft breakaway and running torque (paragraph 6-4).

j. Install protective closures.

k. Leak test fuel turbopump as outlined in paragraph 6-39.

6-26. INSTALLING FIRST-STAGE TURBINE WHEEL (FUEL TURBOPUMPS 460390-191 AND -201). (See figure 6-1 for parts identification.)

a. Obtain the following equipment and materials, or their equivalents:

(1) DC11 compound (Dow Corning Corp).

(2) Fuel turbine disk removal guide pin kit 9022277.

(3) First-stage turbine wheel gage 88-460088.

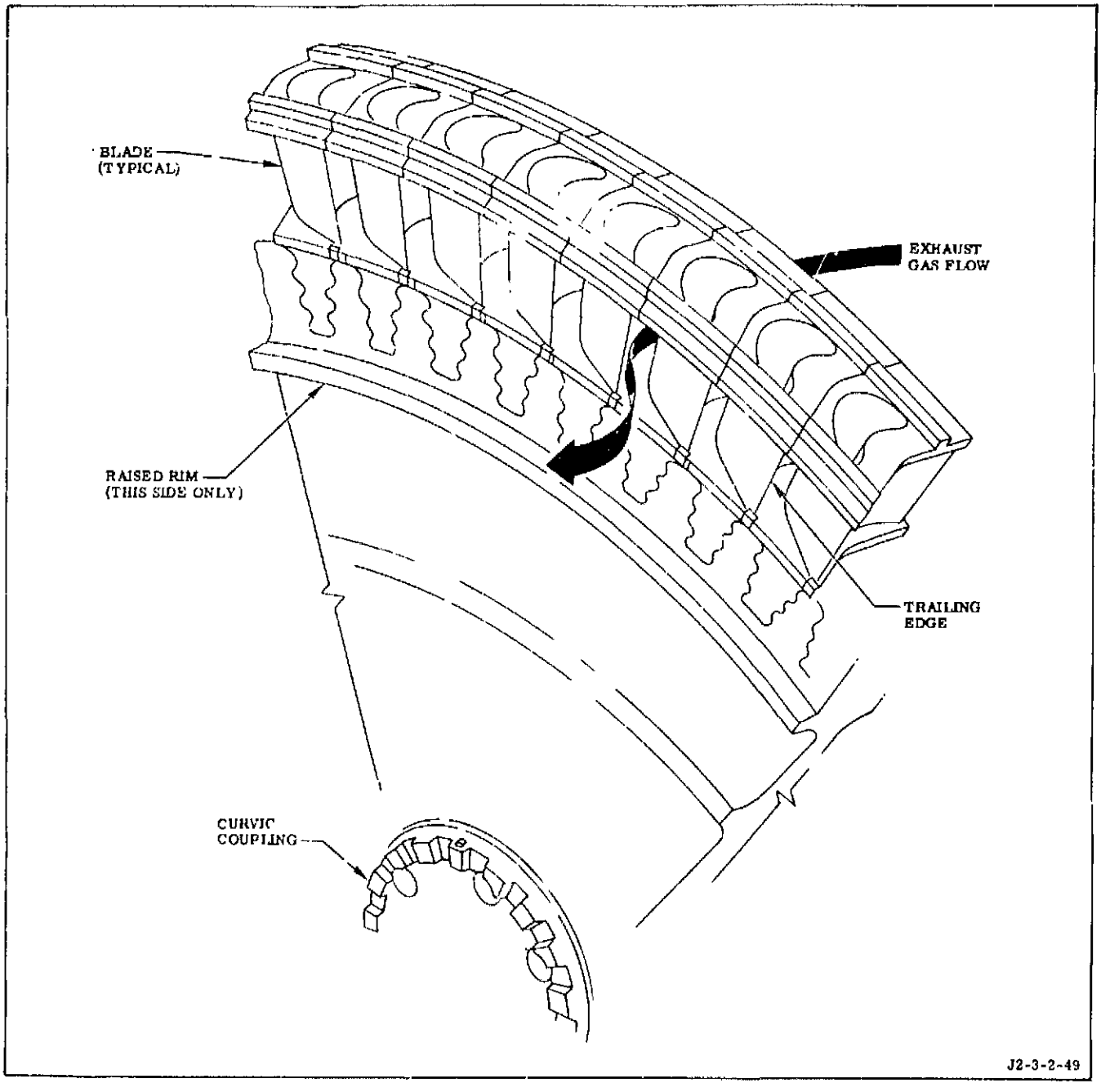


Figure 6-3. Blade Orientation of Installed First-Stage Turbine Wheel

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Leak test omniseal and primary, secondary, and turbine seals (paragraph 6-39) before installing turbine wheels and stator.

d. Carefully apply DC11 compound (Dow Corning Corp) to area of rotor inboard of curvic teeth, to aid in installation of lock (16). Do not apply compound to curvic teeth, or allow compound to enter boltholes.

CAUTION

Extreme care must be used when installing first-stage turbine wheel. Movement of lock (16) can damage lock or turbine wheel.

e. Install lock (16) on rotor curvic. Make sure lock engages rear bearing nut.

CAUTION

Raised rim must be visible or damage to turbopump can result (figure 6-9).

f. Using disk removal guide pins 9022290 and ball-lock pins SL-19212, from fuel turbine disk removal guide pin kit 9022277, install first-stage turbine wheel (17) with raised rim at base of blade slots facing turbine exhaust end and B-balance matchmarks alined (figure 6-2). Make sure raised rim at 11.090 to 11.210-inch diameter on wheel is visible after wheel is installed.

g. Using 2 bolts RD111-3003-7537, install curvic coupling wrench 9022306-3 to secure first-stage turbine wheel while installing stator assembly. Torque bolts to 25-35 in-lb. Leave guide pins 9022290 installed.

h. Measure axial runout at raised rim at 11.090- to 11.210-inch diameter at base of blade slots facing turbine exhaust end of first-stage turbine wheel. Runout must not exceed 0.010 inch total indicated reading.

i. Observe blade orientation as shown in figure 6-9.

CAUTION

Slide must be in no-go position or damage to tool or turbopump can result.

j. Install gage 88-460088 with slide in no-go position as shown in figure 6-10.

k. Using tool, check for a go or no-go condition between bracket and first-stage turbine wheel. A no-go condition indicates wheel is installed correctly; a go condition indicates wheel is installed backward. If a go condition exists notify Rocketdyne Representative.

l. Remove gage 88-460088.

m. Install stator assembly (18) and aline index marks (made during removal) with manifold (19).

n. Measure and record actual dimension A (figure 6-11) from retainer to raised rim at base of blade slots (facing turbine exhaust end). If dimension A is greater than 1.640 inches, the first-stage turbine wheel is backward. Notify Rocketdyne Representative for disposition.

o. Remove curvic coupling wrench. If turbine end of pump is down, remove wrench bolts slowly until first-stage turbine wheel rests on stator.

p. Perform paragraph 6-25.

6-27. INSTALLING FIRST- AND SECOND-STAGE TURBINE SEALS (HONEYCOMB) (FUEL TURBOPUMPS 460390-191 AND -201). (See figure 6-1 for parts identification.)

a. Make sure stator assembly (18) has been assembled as outlined in paragraph 6-6.

b. Perform paragraph 6-26.

6-28. INSTALLING TURBINE SEAL (FUEL TURBOPUMPS 460390-191 AND -201). When replacing the turbine seal, the secondary mating ring must be replaced also. (See figure 6-1 for parts identification.)

a. Obtain a seal pilot 9021822 or T-5024793-101.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

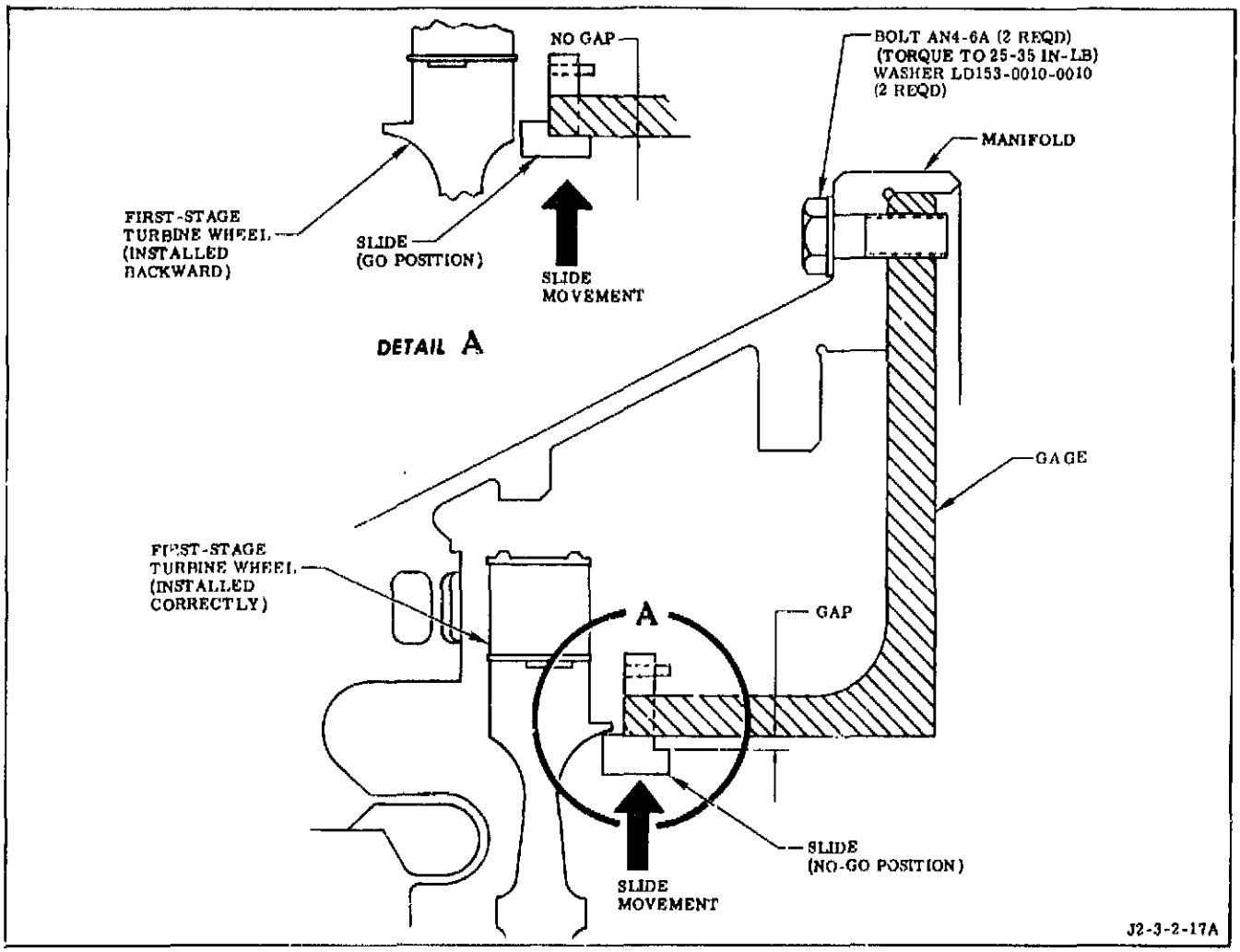


Figure 6-10. Installation and Use of First-Stage Turbine Wheel Gage Kit 9021809

c. Measure and record dimensions A and B as shown in figure 6-12. A + B must be ±0.004-inch of sum dimensions A and B recorded in paragraph 6-7.

d. Install secondary mating ring (10).

e. Install nut (11) on shaft handtight. (Nut has left-hand threads.)

f. Install coupling wrench 9022306-3 on pump shaft with bolts RD111-3003-7513. Torque bolts to 25-35 in-lb (figure 6-6).

g. Assemble spanner wrench 9022307 and retainer 9022308. Adjust spanner wrench and retainer until wrench engages nut and retainer mates with manifold (19) flange.

h. Secure retainer to manifold flange with bolts AN4-6. Torque bolts to 25-35 in-lb.

i. Hold pump shaft with curvic coupling wrench 9022306-3 and torque nut (11) to 225 ±25 ft-lb. Remove curvic shaft coupling wrench 9022306-3 and bolts.

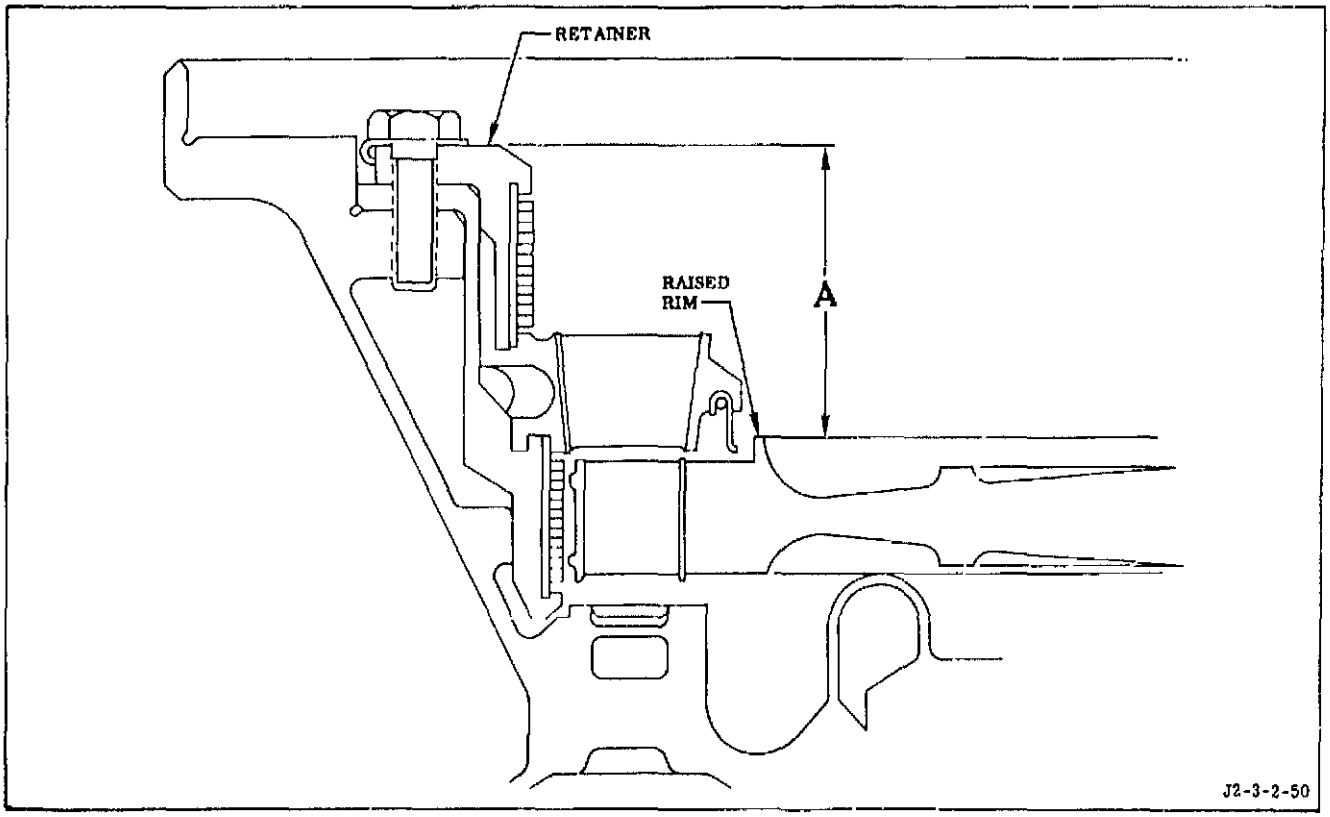


Figure 6-11. Determining Measurement from Stator Assembly Flange to Raised Rim on First-Stage Turbine Wheel

CAUTION

If turbopump is vertical (turbine end down), seal pilot must be supported at all times. Seal pilot will drop free after turbine seal clears pilot.

j. Install turbine seal (13) as follows:

(1) Taking care not to damage seal carbon segments, slide turbine seal (13) onto flat surface of seal pilot 9021822 or T-5024739.

(2) Place seal pilot with turbine seal (13) and gasket (12) against secondary mating ring (10).

(3) Aline slots in turbine seal with pins on mating flange.

(4) Carefully slide turbine seal and gasket off seal pilot onto secondary mating ring (10).

(5) Holding turbine seal in-place, remove seal pilot.

(6) Secure turbine seal with tabs (14) and bolts (15). Torque bolts to 95 ±5 in-lb.

k. Perform paragraph 6-26.

6-29. INSTALLING SECONDARY SEAL (FUEL TURBOPUMPS 460390-191 AND -201). When the secondary seal is replaced the secondary mating ring must be replaced also. (See figure 6-1 for parts identification).

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume 1.

NOTE

Steps b through k apply only when new secondary seal is being installed.

b. Install secondary mating ring (10).

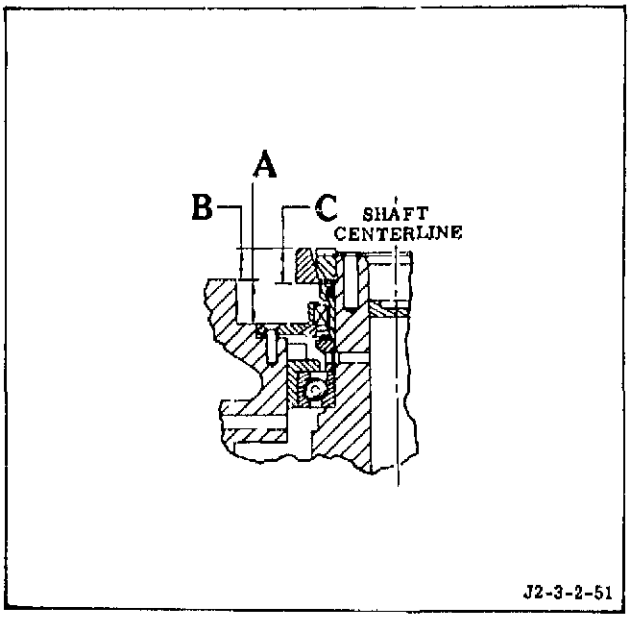


Figure 6-12. Determining Fuel Turbopump Secondary Seal Measurements

c. Install nut (11) on shaft handtight. (Nut has left-hand threads.)

d. Install coupling wrench 9022306-3 on pump shaft with bolts RD111-3003-7513. Torque bolts to 25-35 in-lb (figure 6-5).

e. Assemble spanner wrench 9022307 and retainer 9022308. Adjust spanner wrench and retainer until wrench engages nut and retainer mates with manifold (19) flange.

f. Secure retainer to manifold flange with bolts AN4-6. Torque bolts to 25-35 in-lb.

g. Hold pump shaft with curvic coupling wrench 9022306-3 and torque nut (11) to 225 ±25 lt-lb. Leave shaft curvic coupling wrench 9022306-3 installed.

h. Measure and record dimensions A, B, and C (figure 6-12). Determine shim thickness required to obtain 0.698 ±0.005 inch operating length of secondary seal (8) as follows: A + B - C - 0.698 ±0.005 inch equals shim thickness.

i. Remove nut (11). (Nut has left-hand threads.)

j. Remove secondary mating ring (10).

k. Select a shim (7) to obtain dimensions calculated in step h. Record shim dash number and actual thickness.

l. Install shim (7).

m. Install secondary seal (8) and secure with bolts (9). Torque bolts to 50 ±5 in-lb and safetywire.

n. Perform paragraph 6-30.

6-30. INSTALLING OMNISEAL (FUEL TURBOPUMPS 460390-191 AND -201). The omniseal may be replaced or inspected and reinstalled as part of the spacer. (See figure 6-1 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. If omniseal (5) was removed from spacer (6) during removal, install new omniseal in spacer with opening in seal toward pump end of spacer (figure 6-1).

c. Install spacer (6) on rotor shaft, with largest shoulder of spacer toward turbine end of pump.

d. Perform paragraph 6-31.

6-31. INSTALLING PRIMARY SEAL (FUEL TURBOPUMPS 460390-191 AND -201). When the primary seal is replaced the primary mating ring must be replaced also. (See figure 6-1 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Install primary mating ring (1) on rotor shaft with largest shoulder of ring toward turbine end of pump.

NOTE

Steps c and d apply only when a new seal is being installed.

c. Measure and record dimensions A and B (figure 6-13) to obtain operating length of primary seal. Using the equation A - B - C, 0.110 ±0.005 inch - C is equal to required shim (2) thickness.

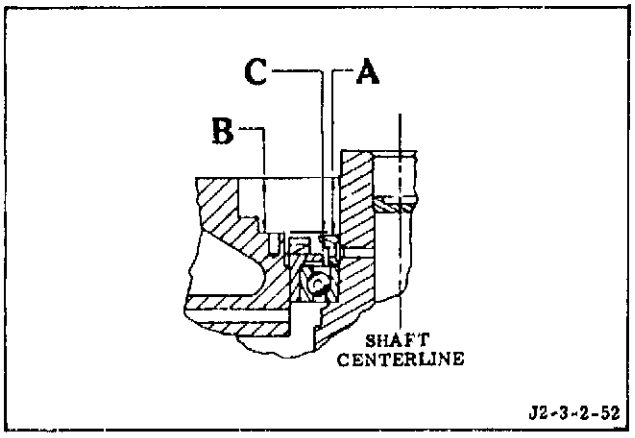


Figure 6-13. Determining Fuel Turbopump Primary Seal Measurements

d. Select a shim (2) to obtain dimension calculated in step c. Record shim dash number and actual thickness.

e. Install shim (2) and primary seal (3), and secure with new bolts (4). Torque bolts to 47 ±5 in-lb.

f. Punch-stake each primary seal bolt (4) four equally spaced places. Use a centerpunch and punch edge of bolthead and seal material.

g. Perform paragraph 6-32.

6-32. INSTALLING SECOND-STAGE TURBINE WHEEL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). If stator assembly (18) and first-stage turbine wheel (17) have been removed with the second-stage turbine wheel, install parts as outlined in paragraph 6-33. (See figure 6-6 for parts identification.)

a. Obtain the following equipment and material, or their equivalents:

(1) Molykote L paste (Dow Corning Corp).

(2) Fuel turbopump turbine wheel removal tool kit 9019356.

(3) Check tool 9021820 or T-5033143.

(4) Stud torque wrench 9021821 or T-5033142.

(5) Clean, lint-free cloths.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Liberally lubricate second-stage turbine wheel stud bores with Molykote L paste (Dow Corning Corp).

d. Using clean dry lint-free cloth remove any lubricant from interface of first-stage turbine wheel and second-stage turbine wheel.

e. If turbopump is vertical (turbine end downward), aline matchmarks and turbine wheel bores with studs, and install second-stage turbine wheel. Make sure wheel puller flange is visible after wheel is installed. Make sure stud numbered 1 is immediately clockwise of turbine wheel B balance matchmark. If turbopump is not vertical, proceed to step j.

f. Aline stud lock (24) flats with slots in second-stage turbine wheel studs, install stud locks with longest legs toward turbopump.

g. Place lock tabs (25) over studs.

h. Lubricate threads of nuts (26) and interface of lock tabs (25) with nuts (26) with Molykote L paste.

i. Install nuts (26) and tighten fingertight. Do not allow studs to rotate. Make sure stud locks are in place.

j. If turbopump is other than vertical (turbine end downward), using adapter 9019357 and puller assembly 9019358 from fuel turbopump turbine wheel removal tool kit, install second-stage turbine wheel as follows:

(1) With screw backed out so that pusher clears studs, place puller assembly against wheel-puller flange of second-stage turbine wheel.

(2) Position both halves of adapter 9029357 simultaneously around wheel-puller flange and spreader ring. Secure adapter halves together with 2 screws NAS1351-4-16. Torque screws to 23-29 in lb.

(3) Lift turbine wheel and puller assembly, aline matchmarks and turbine wheel bores with studs, and install second-stage turbine wheel. Make sure wheel-puller flange is visible after wheel is installed.

(4) Remove puller assembly from second-stage turbine wheel. Make sure stud numbered 1 is immediately clockwise of turbine wheel B balance matchmark.

(5) Aline stud lock (24) flats with slots in second-stage turbine wheel studs and install stud locks (24) with the longest legs toward the turbopump.

(6) Place lock tabs (25) over studs.

(7) Install nuts (26) and tighten finger-tight. Do not allow studs to rotate. Make sure stud locks are in place.

k. Securely tape wheel to manifold at blade area, to keep wheel from turning while torquing.

l. Verify calibration of check tool. (Refer to R-3825-5.)

m. Using stud torque wrench and a 4-inch long, 1/4-inch drive extension, torque studnuts in sequence 1, 4, 2, 5, 3, and 6 to 60 ±5 in-lb.

n. Using torque wrench and socket, loosen 2 diametrically opposed nuts and retorque to 10 (+5, -0) in-lb.

o. Using check tool and depth gage, measure and record dimension from top of check tool to top of 2 studs in step n. Make sure legs of check tool are positioned between (not on) lock tabs (25).

p. Using torque wrench and socket, torque the 2 studs to 60 ±5 in-lb.

q. Repeat steps n through p until all studs have been measured and recorded.

CAUTION

Any stud stretched in excess of 0.015 inch during torquing must be replaced. Do not exceed 200 in-lb of torque on stud square head at any time.

r. Using check took, depth gage, torque wrench and socket, torque studnuts to obtain a stud stretch of 0.0127 (+0.002, -0.000) inch, as follows:

(1) Torque studnuts in sequence 1, 4, 2, 5, 3, and 6, in increments not to exceed 20 in-lb, and repeat step o for each increment.

(2) Repeat substep 1 until stretch, with respect to dimension recorded in step o, is equal to 0.0127 (+0.002, -0.000) inch

(3) If specified stretch is exceeded in final torquing operation, loosen stud nut to last previous measurement and repeat substep 1 with a lesser torque until specified stretch is obtained. Do not obtain specified stretch by loosening as the final operation.

s. Secure stud nuts with lock tabs (25).

t. Measure axial runout at the 10.82 ±0.03 inch diameter on second-stage turbine wheel. Runout must not exceed 0.005-inch total indicated reading.

u. Measure and record dimension A (figure 6-7), from turbine exhaust flange to second-stage turbine wheel at the 10.82 ±0.003-inch diameter. This dimension must agree within 0.020-inch with dimension recorded during removal. (Refer to paragraph 6-12.)

v. Leak test fuel turbopump as outlined in paragraph 6-39.

6-33. INSTALLING FIRST-STAGE TURBINE WHEEL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). (See figure 6-6 for parts identification.)

a. Obtain the following equipment and material, or their equivalents:

(1) Molykote L paste (Dow Corning Corp).

(2) Clean, lint-free cloths.

(3) Fuel turbopump turbine wheel removal tool kit 9019356.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Leak test omniseal and primary, secondary, and turbine seals (paragraph 6-39) before installing turbine wheels and stator.

d. Liberally lubricate stud shanks and rotor end of threads with Molykote L paste (Dow Corning Corp) and install studs, indexed during removal, in turbopump rotor assembly. Studs must protrude 3.850 ±0.030 inches when measured with stud lock flats facing inward.

NOTE

Studs are numbered 1 through 6 clockwise, starting with number 1, located clockwise from B balance matchmark on rotor.

e. Liberally lubricate first-stage turbine wheel stud bores with Molykote L paste (Dow Corning Corp)

f. Using clean dry lint-free cloth, remove any lubricant from interface of rotor and first-stage turbine wheel.

g. If turbopump is vertical (turbine end downward), aline matchmarks and turbine wheel bores with studs, and install first-stage turbine wheel. Make sure first-stage turbine wheel puller flange is visible after installation. Temporarily install 2 nuts (26) on diametrically opposed studs (23) to secure first-stage turbine wheel. Do not allow studs to rotate. Make sure stud numbered 1 is immediately clockwise of turbine wheel B balance matchmark.

h. If turbopump is other than vertical, using adapter 9019357 and puller assembly 9019358 from fuel turbopump turbine wheel removal tool kit, install first-stage turbine wheel as follows:

(1) With screw backed out so that pusher clears studs, place puller assembly against wheel-puller flange of first-stage turbine wheel.

(2) Position both halves of adapter 9019357 simultaneously around wheel-puller flange and spreader ring. Secure adapter halves together with 2 screws NAS1351-4-16. Torque screws to 23-29 in-lb.

(3) Lift turbine wheel and puller assembly, aline matchmarks and turbine wheel bores with studs, and install first-stage turbine wheel.

(4) Remove puller assembly from first-stage turbine wheel. Make sure stud numbered 1 is immediately clockwise of turbine wheel B balance matchmark.

i. Aline index marks (made during removal) with manifold (19), and install stator assembly (18). Secure stator assembly with bolts (21) and tabs (20). Torque bolts to 70 ±10 in-lb.

NOTE

If turbopump is vertical (turbine end downward), first-stage turbine wheel will rest on stator assembly during installation of the stator assembly.

j. Remove nuts (26).

k. Perform paragraph 6-34.

6-34. INSTALLING FIRST- AND SECOND-STAGE TURBINE SEALS (HONEYCOMB) (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). (See figure 6-6 for parts identification.)

a. Make sure stator assembly (18) has been assembled as outlined in paragraph 6-13.

b. Perform paragraph 6-33.

6-35. INSTALLING TURBINE SEAL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). When replacing the turbine seal, the secondary mating ring must be replaced also. (See figure 6-6 for parts indentification.)

a. Obtain Molykote L paste (Dow Corning Corp).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Install secondary mating ring (10).

d. Carefully apply Molykote L paste (Dow Corning Corp) to junction area on one side of shaft locks (11).

e. Install shaft locks (11) with paste toward rotor. Do not allow paste to contact threads on rotor.

f. Assemble spanner wrench 9022307 and retainer 9022308. Adjust spanner wrench and retainer until wrench engages nut (12) and retainer mates with manifold (19) flange.

g. Secure retainer to manifold flange with bolts AN4-6. Torque bolts to 25-35 in-lb.

h. Hold shaft with coupling wrench 9019365 and torque nut (12) to 225 ±25 ft-lb. Remove shaft coupling wrench 9019365 and bolts.

i. Measure and record dimensions A and B as shown in figure 6-12. A and B must be ± 0.004-inch of dimensions A and B recorded in paragraph 6-14.

j. Bend locks (11) to secure shaft nut (12). Bend unused tabs over nut.

CAUTION

If turbopump is vertical (turbine end down), seal pilot must be supported at all times. Seal pilot drops free after turbine seal clears pilot.

k. Taking care not to damage seal carbon segments, slide turbine seal (14) onto flat surface of seal pilot 9021822 or T-5024739. Place seal pilot with turbine seal (14) and gasket (13) against secondary mating ring (10). Aline slots in turbine seal with pins on mating flange. Carefully slide turbine seal and gasket off seal pilot onto secondary mating ring (10). Holding turbine seal in-place, remove seal pilot. Secure turbine seal with tabs (15) and bolts (16). Torque bolts to 95 ±5 in-lb.

l. Perform paragraph 6-36.

6-36. INSTALLING SECONDARY SEAL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). When the secondary seal is replaced, the secondary mating ring must be replaced also. (See figure 6-6 for parts identification.)

NOTE

Steps c through l apply only if new secondary seal is being installed.

a. If a new secondary seal (8) is to be installed obtain a fuel turbopump stud drive shaft wrench kit 9022284-11.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Install secondary mating ring (10).

d. Install nut (12) on shaft handtight. (Nut has left-hand threads.)

e. Install shaft coupling wrench 9019365 from fuel turbopump shaft curvic wrench kit with bolts 9019366 (figure 6-5). Torque bolts to 60 ±5 in-lb.

f. Assemble spanner wrench 9022307 and retainer 9022308. Adjust spanner wrench and retainer until wrench engages nut (12) and retainer mates with manifold (19) flange.

g. Secure retainer to manifold flanges with bolts AN4-6. Torque bolts to 25-35 in-lb.

h. Hold pump shaft with coupling wrench 9019365 and torque nut (12) to 225 ±25 ft-lb. Leave shaft coupling wrench installed.

i. Measure and record dimensions A, B, and C (figure 6-12). Determine shim thickness required to obtain 0.698 ±0.005 inch operating length of secondary seal (8) as follows: A + B - C - 0.698 ±0.005 inch equals shim thickness.

j. Remove nut (12). (Nut has left-hand threads.)

k. Remove secondary mating ring (10).

l. Select shim (7) to obtain dimension calculated in step i. Record shim dash number and actual thickness.

m. Install shim (7).

n. Install secondary seal (8) and secure with bolts (9). Torque bolts to 50 ±5 in-lb and safetywire.

o. Perform paragraph 6-37.

6-37. INSTALLING OMNISEAL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171. The omniseal may be replaced or inspected and reinstalled as part of the spacer. (See figure 6-6 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. If omniseal (5) was removed from spacer (6), install new omniseal in spacer with opening in seal toward pump end of spacer (figure 6-7).

c. Install spacer (6) on rotor shaft, with largest shoulder of spacer toward turbine end of pump.

d. Perform paragraph 6-38.

6-38. INSTALLING PRIMARY SEAL (FUEL TURBOPUMPS 460160-61 THROUGH -81 AND 460390-121 THROUGH -171). When the primary seal is replaced, the primary mating ring must be replaced also. (See figure 6-6 for parts identification.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Install primary seal mating ring (1) on rotor shaft, with largest shoulder on ring toward turbine end of turbopump.

NOTE

Steps c and d apply only when a new primary seal is being installed.

c. Measure and record dimensions A and B (figure 6-13) to obtain operating length of primary seal. Using the equation A - B = C, 0.110 ±0.005 inch - C is equal to required shim (2) thickness.

d. Select shim (2) to obtain dimension calculated in step c. Record shim dash number and actual thickness.

e. Install shim (2) and primary seal (3), and secure with new bolts (4). Torque bolts to 47 ±5 in-lb.

f. Punch-stake each primary seal bolt (4) four equally spaced places. Use a center-punch and punch edge of bolthead and seal material.

g. Perform procedure steps as outlined in paragraph 6-39.

6-39. TESTING.

6-40. Testing the fuel turbopump consists of seal leak tests at ambient temperatures with the turbopump installed in the engine, using procedures and criteria in R-3825-1B.

SECTION VII

HEAT EXCHANGER

WARNING

AUTOMATIC INERT GAS ARC WELDING SET G3128 AND COMPONENTS ADAPTER SET 9016796 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

7-1. SCOPE. This section contains allowable field level repair and post-maintenance test requirements for the heat exchanger.

7-2. REPAIRING.

7-3. Field repair of the heat exchanger consists of minor welding of the heat exchanger shell. Welding (paragraph 7-4) is not permitted or coils, areas adjacent to coils, or sealing surfaces of flanges or bosses. Figure 7-1 lists type and disposition for typical heat exchanger damage. Rocketdyne Representative will provide disposition for damage outside the scope of figure 7-1.

7-4. WELDING.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment and materials, or their equivalents:

(1) Automatic Inert Gas Arc Welding Set G3128.

(2) Welding electrode AMS5787 (Hastelloy W).

(3) Hand-held metal grinder.

(4) Trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302).

(5) Clean cloths.

(6) CRES wire brush.

(7) Deionized water.

(8) Nitric acid (42 Baume).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Grind cracked area, leaving a minimum material thickness of one-half base metal. Blend area evenly with base metal.

WARNING

The following procedure specifies trichloroethylene or trichloroethane which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquid can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302) which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air resulting in suffocation.

d. Clean area to be welded by handwiping with a clean cloth moistened with trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302).

Condition	Description	Disposition
Cracks in welds or parent material of shell.	4 inches or less long.	Tungsten-inert gas weld with stainless rod. (Refer to paragraph 7-4.)
	More than 4 inches long.	Notify Rocketdyne Representative.
Scratches or grind marks in parent material of shell or welds, except on surfaces indicated as sealing surfaces.	5 percent or less of material thickness.	Acceptable.
	More than 5 percent of material thickness.	Notify Rocketdyne Representative.
Scratches or grind marks, nicks, waviness, and imperfections that can affect flange sealing surfaces.		Notify Rocketdyne Representative.
Cracks in bellows.		Notify Rocketdyne Representative.
Cracks in tubes or welds of coils.		Notify Rocketdyne Representative.
Dents in tubes.	0.10 inch or less deep and 0.40 inch or less radius.	Acceptable.
	More than 0.10 inch deep.	Notify Rocketdyne Representative.
Dents in shell.	0.25 inch or less deep and 1.00 inch or less radius.	Acceptable.
	More than 0.25 inch deep.	Notify Rocketdyne Representative.

Figure 7-1. Heat Exchanger Damage Limits

e. Provide an inert gas backup during and after welding until weld cools. A minimum of 6 volume changes is required before welding.

f. Using tungsten-inert-gas (TIG) welding and welding electrode AMS5789 (Hastelloy W) as filler rod, weld cracks.

g. Allow weld to cool; then remove backup gas supply.

h. Remove all traces of weld scale and oxides with CRES wire brush. Minor weld discoloration is permissible.

WARNING

The following procedure specifies nitric acid, which must not be allowed to come in contact with any part of the body. Eye protection and protective clothing must be worn by personnel handling nitric acid. Spillage may cause fire. Nitric acid must be used in a well-ventilated area since the vapors are extremely hazardous. Inhalation of the vapors or contact with the liquid can cause serious injury or death. In case of contact, the skin or eyes must immediately be flushed with water for at least 15 minutes and given medical attention.

i. Swab-passivate weld area with a solution of equal parts of 42 Baume nitric acid and deionized water. Swab area a total of 6 times at 10-minute intervals.

j. Thoroughly rinse passivated area with deionized water and dry with clean cloth.

k. Leak test heat exchanger. (Refer to paragraph 7-5.)

7-5. TESTING. Testing the heat exchanger consists of a shell leak test and a vacuum mass spectrometer leak test of the coils.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment and materials, or their equivalents. Items 3 through 5 are part of components adapter set 9016796.

(1) Pneumatic test chamber 61312.

(2) Gaseous helium source, pressurized to a minimum of 30 psig. Helium must conform to the pressurizing and purging requirements for helium in R-3825-3, Volume I.

(3) Heat exchanger adapter set 9021875.

(4) Tube 9021881.

(5) Leak detector set 24-120A or 24-120B.

(6) Leak-test compound (MSFC-SPEC-384). ▌

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Install test adapter set on heat exchanger. (See figure 7-2.)

d. Connect pressurized helium source to shell inlet port. Provide way to prevent pressurizing in excess of 30 psig and way to vent heat exchanger.

e. Install pressure-type plugs in all open ports of heat exchanger and test plates.

f. Pressurize heat exchanger to 20 (+5, -0) psig.

g. Using leak-test compound, leak test external portion of heat exchanger including all weld joints, bosses, and bellows. No leakage allowable.

h. Reduce pressure to heat exchanger to zero.

i. Using leak detector set, pull a vacuum of one micron or less on coil outlet po...

j. Pressurize heat exchanger to 5-10 psig.

k. Using leak detector set, measure coil leakage. Leakage must not exceed 1×10^{-6} atm cc/sec.

l. Reduce pressure to heat exchanger to zero.

m. Disconnect leak detector set.

n. Disconnect test hoses and fittings from test setup.

o. Remove test adapters and attaching hardware from heat exchanger.

p. Install heat exchanger protective closures. (Refer to R-3825-3, Volume I.)

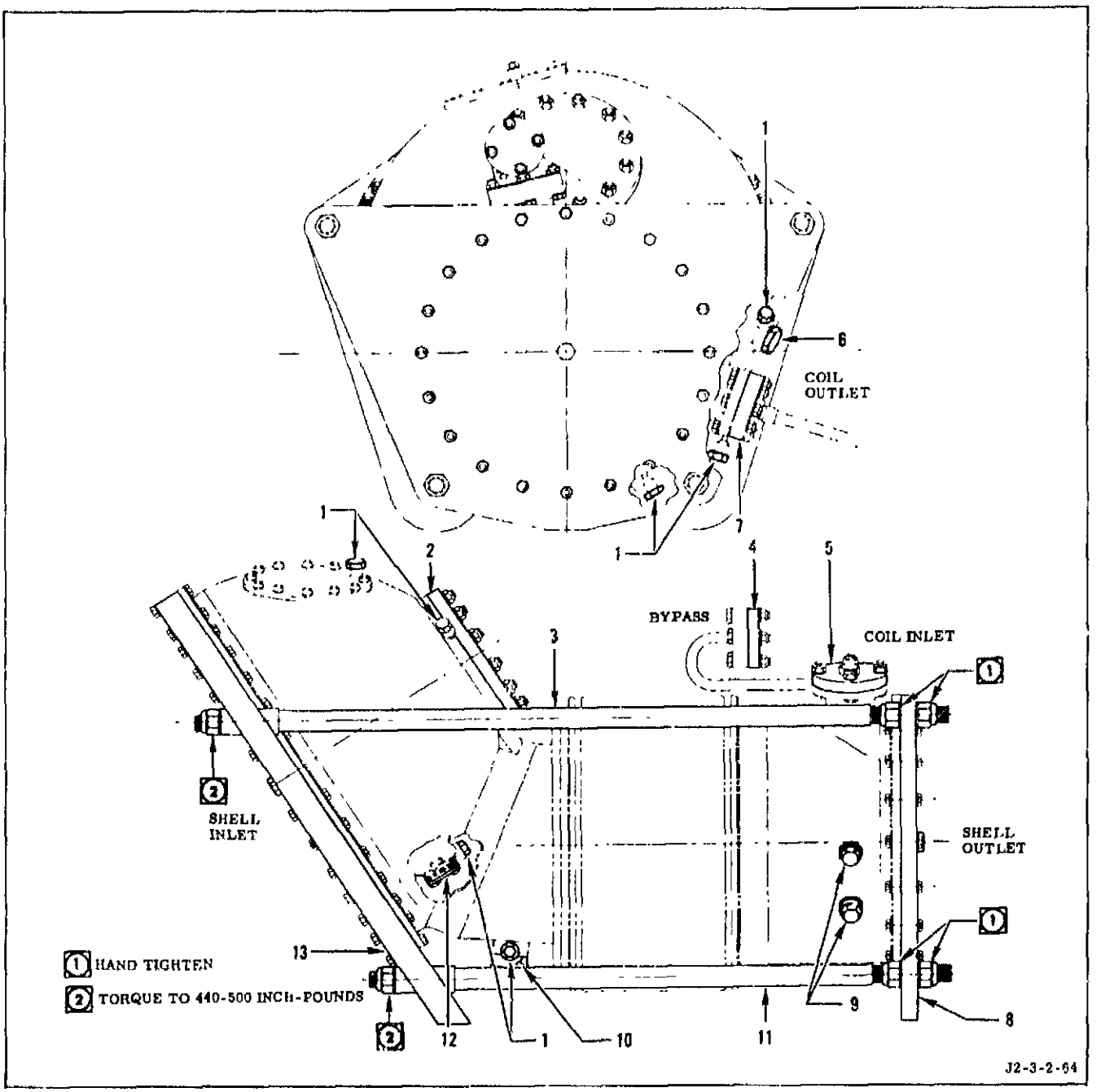


Figure 7-2. GSE Set up for Heat Exchanger (Sheet 1 of 2)

Index No.	Description	Quantity Required
1	AN814-2C Plug	7
	MS28778-2 Packing	7
2	9021883 Plate	
	MS29513-246 Packing	
	RD153-1002-0006 Washer	12
	NAS679C6 Nut	12
	(Torque to 210-280 in-lb.)	
3	9021886-5 Rod[(a)]	2
	RD153-1002-0012 Washer	6
	MS20500-1216 Nut	6
4	9021878 Plate	
	MS29513-215 Packing	
	NAS1004-18A Bolt	4
	RD153-5004-0004 Washer	4
	RD153-1002-0004 Washer	4
	NAS679C4W Nut	4
	(Torque to 61-75 in-lb.)	
5	9021879 Plate	
	MS29513-227 Packing	
	NAS1005-16A Bolt	6
	RD153-5004-0005 Washer	8
	RD153-1002-0005 Washer	8
	NAS679C5 Nut	6
	(Torque to 120-155 in-lb.)	
	NAS1005-10A Bolt	2
	(Torque to 140-170 in-lb.)	
	AN814-4C Plug	
	MS28778-4 Packing	
6	701353 Plug	
	404659 Seal	
7	9021877 Plate	
	MS219513-224 Packing	
	NAS1004-17A Bolt	8
	RD153-5004-0004 Washer	8
	RD153-1002-0004 Washer	8
	NAS679C4W	8
	(Torque to 61-75 in-lb.)	
8	9021885 Plate	
	MS9021-278 Packing	
	NAS1004-18A Bolt	20
	RD153-5004-0004 Washer	20
	RD153-1002-0004 Washer	20
	NAS679C4W Nut	20
	(Torque to 61-75 in-lb.)	
	AN814-4C Plug	
	MS28778-4 Packing	
9	AN814-4C Plug	
	MS28778-4 Packing	
10	9022436 Plate	
	AN6227-11 Packing	
	RD153-5004-0004 Washer	4
	NAS1004-9A Bolt	4
	(Torque to 68-82 in-lb.)	
	AN814-4C Plug	
	MS28778-4 Packing	
11	9021886-3 Rod[(a)]	2
	RD153-1002-0012 Washer	6
	MS20500-1216 Nut	6
12	9022436 Plate	
	AN6227-11 Packing	
	RD153-5004-0004 Washer	4
	NAS1004-8A Bolt	4
	(Torque to 68-82 in-lb.)	
	AN814-4C Plug	
	MS28778-4 Packing	
13	9021884 Plate	
	9021882 Packing	
	NAS1004-26A Bolt	36
	RD153-5004-0004 Washer	36
	RD153-1002-0004 Washer	36
	NAS679C4W Nut	
	(Torque to 61-75 in-lb.)	
	AN814-4C Plug	
	MS28778-4 Packing	
14	9021881 Tube	
	MS28778-8 Packing	

(a) Do not elongate or compress bellows during adjustment of rods and nuts.

Figure 7-2. GSE Setup for Heat Exchanger (Sheet 2 of 2)

SECTION VIII

HELIUM FILL CHECK VALVE

8-1 SCOPE. This section contains preinstallation test requirements for the helium fill check valve. No repair information is included, since the check valve is not field repairable.

8-2. PREINSTALLATION TESTING.

8-3. The preinstallation test of the helium fill check valve consists of reverse leakage and forward flow tests.

a. Obtain the following test equipment and material, or their equivalents:

(1) Pneumatic test chamber 61312.

(2) Pressure test fixture T-5029429.

(3) Pneumatic Flow Tester G3104.

(4) Gaseous nitrogen source, pressurized to a minimum of 1,650 psig. Nitrogen must conform to pressurizing and purging requirements for nitrogen in R-3825-3, Volume I.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

NOTE

When this procedure requires the application of pressure, the rate of application must not exceed 400 psig per second.

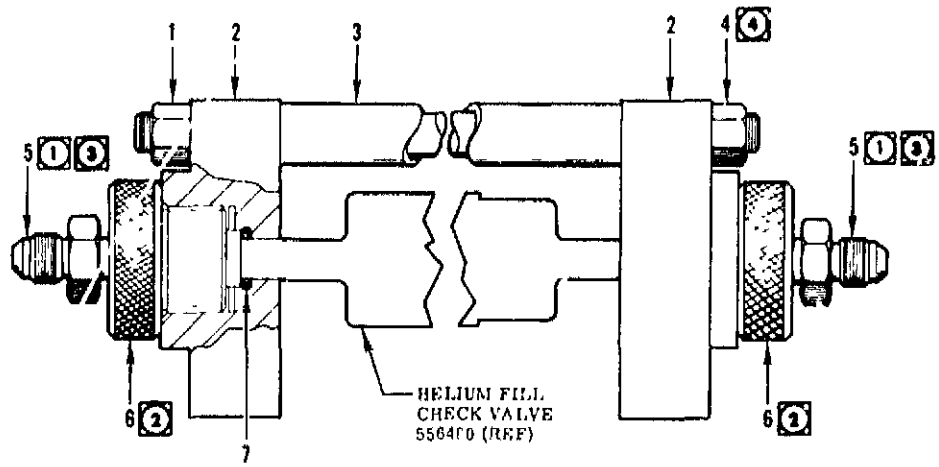
c. Install valve in pressure test fixture (see figure 8-1).

d. Apply 1,500 (+0, -15) psig nitrogen pressure to outlet port and measure leakage from inlet port. Leakage must not exceed 3 scim.

e. Slowly apply pressure to inlet port until a minimum of 1,728 scim is flowing from outlet port. Pressure must not exceed 22 psig at inlet port.

f. Secure test equipment and remove valve from pressure test fixture.

g. Repackage helium fill check valve and attach condition tag.



INDEX NO.	T 5079429 DETAIL NO.	QTY	DESCRIPTION
1	514	4	WELD ASSY
2	511	2	END PLATE
3	518	4	CRES PIPE
4	506	4	NUT (MS20500-624)
5	519	2	NIPPLE (AN816-6-6)
6	510	2	PRESSURE ADAPTER
7	512	2	TEFLON O-RING

1. APPLY (METHOD I, R-3825-3, VOLUME I) THREAD SEALANT TAPE.
2. HAND TIGHTEN SUFFICIENTLY TO SEAT TEFLON O-RING (7).
3. NIPPLES AN816 OF A SIZE TO MATE TO AVAILABLE HOSES ARE ACCEPTABLE ALTERNATES.
4. TORQUE TO 20-25 IN-LB.

J2-3-2-28

Figure 8-1. Helium Fill Check Valve Preinstallation Test Setup

SECTION IX

IGNITION DETECTOR PROBE

9-1. SCOPE. This section contains ignition detector probe preinstallation test requirements. Repair information is not included, since the probe is not field repairable.

9-2. PREINSTALLATION TESTING.

9-3. Testing the ignition detector probe consists of resistance measurements. (See figure 9-1 for electrical schematic of the detector probe.)

a. Obtain a Wheatstone Bridge Set, Model 5305 (Leeds and Northrup Co), or an equivalent.

b. Check that the following pin-to-pin or pin-to-shell resistances are within the noted values:

(1) Pin A to pin B and pin B to pin C; 100 ±2.5 ohms.

(2) Pin A to pin C; 200 ±10 ohms.

(3) Pin D to pin E and pin F to receptacle shell; less than 0.1 ohm.

(4) Pin B to pin D, pin B to pin F, pin D to pin F, pin D to receptacle shell, and pin B to receptacle shell; 100,000 ohms minimum.

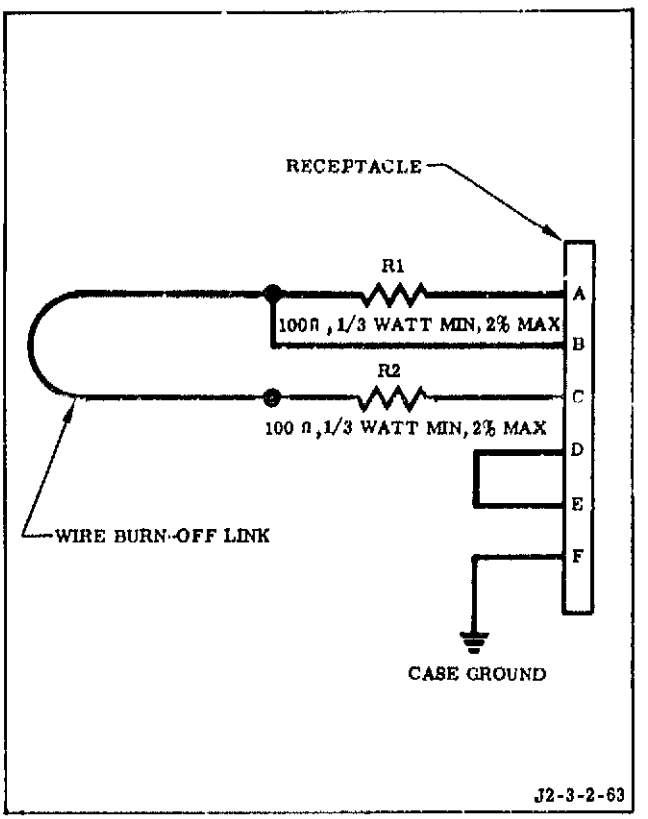


Figure 9-1. Ignition Detector Probe Electrical Schematic

SECTION X

INSULATION

10-1. SCOPE. This section contains insulation repair information. Post-maintenance testing is not included, since testing is not required to validate repairs covered by this section.

10-2. REPAIRING INSULATION.

10-3. Refer to the appropriate paragraph (by component title) for insulation repair procedures.

10-4. ELECTRICAL CONTROL ASSEMBLY.

10-5. The electrical control assembly insulation is pre-cast, silicone-base foam.

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-7.

c. Repair damage that exceeds limits of step b as outlined in paragraph 10-8.

10-6. REPAIRING MINOR INSULATION DAMAGE.

a. Obtain the following equipment and materials, or their equivalents:

(1) Clean, lint-free cloths.

(2) Sandpaper, No. 80 grit.

(3) Silicone primer RB0120-036 (Rocketdyne).

(4) Natural-bristle paintbrush, 2-inch, disposable.

(5) Soft-bristle brush.

(6) Spatula, stainless-steel, 6-inch blade.

(7) External coating RB0120-030 (Rocketdyne).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Wipe damaged area with clean, lint-free cloth to remove grease and soil.

d. Using sandpaper, sand damaged area.

e. Brush damaged area with a soft-bristle brush to remove loose particles.

WARNING

The following procedure specifies silicone primer RB0120-036, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

f. Using paintbrush liberally apply silicone primer to entire surface.

WARNING

The following procedure specifies external coating RB0120-030, which may irritate skin. Protective clothing must be worn when handling coating. In case of contact, wash skin with soap and water.

g. Using spatula, mix coating by stirring one gram (53 drops) of catalyst into 160 grams of base coating at 80°F. Mixture working life is 5-10 minutes.

h. Apply coating in one direction only with paintbrush.

i. Allow coating to cure at least 72 hours before handling.

10-7. REPAIRING MEDIUM DAMAGE, PRECAST, SILICONE BASE FOAM INSULATION.

a. Obtain the following equipment and materials, or their equivalents.

(1) Clean, lint-free cloths.

(2) Wooden or plastic scraper. (Required only if damage extends to base metal.)

(3) Sandpaper, No. 80 grit.

(4) Soft-bristle brush.

(5) Silicone primer RB0120 036 (Rocketdyne).

(6) Neoprene gloves.

(7) Silicone-base foam and catalyst RB0130-068 (Rocketdyne).

(8) Gaseous nitrogen or helium. (Required only, if desired, to remove loose particles by blowing rather than brushing.)

(9) External coating RB0120-030 (Rocketdyne).

(10) Spatula, stainless-steel, 6-inch blade.

(11) Natural-bristle paintbrush, 2-inch, disposable.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Wipe damaged area with clean cloth to remove grease and soil.

d. When damage extends to base metal, remove damaged insulation with plastic scraper.

e. Using sandpaper, sand area, undercutting edges of insulation slightly to provide a better bond. Do not sand base metal.

f. Brush damaged area with soft-bristle brush to remove loose particles.

WARNING

The following procedure specifies silicone primer RB0120-036, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

g. Apply uniform brush coat of silicone primer to exposed metal surface. Allow one hour drying time. Gently wipe off milky surface of primer until a clean, translucent film is obtained.

WARNING

The following procedure specifies silicone-base foam and catalyst RB0130-068, which may irritate skin. Protective clothing must be worn when handling material. In case of contact, wash skin with soap and water.

h. Prepare silicone-base foam material as follows:

(1) Wear neoprene gloves.

(2) Place foam on a piece of metal, glass, or a sheet of polyethylene. Flatten foam into thin, round shape.

(3) Pour half of catalyst over foam. Immediately knead material by hand. Flatten again and pour remainder of catalyst on foam, kneading it again. Complete kneading in one minute, since foaming and curing start immediately.

i. Place foam material on repair area and press firmly into place. (Expansion of material continues for 15-30 minutes.)

j. Allow 4 hours to cure; then remove excess material by cutting or scraping with plastic or wood scraper. Small amounts may be removed by sanding.

k. After trimming or sanding, remove loose particles with low-pressure gaseous nitrogen or helium, or by brushing.

WARNING

The following procedure specifies external coating RB0120-030, which may irritate skin. Protective clothing must be worn when handling coating. In case of contact, wash skin with soap and water.

l. Using spatula, mix external coating by stirring one gram (53 drops) of catalyst into 160 grams of base coating at 80°F. Mixture working life is 5-10 minutes.

m. Apply coating in one direction only with natural-bristle paintbrush.

n. Allow coating to cure for at least 72 hours before handling.

10-8. REPAIRING MAJOR DAMAGE, PRE-CAST, SILICONE-BASE FOAM INSULATION.

a. Obtain the following equipment and materials, or their equivalents:

(1) Sharpened wooden or plastic scraper for removing damaged insulation.

(2) Silicone primer RB0120-036 (Rocketdyne).

(3) Paintbrush to apply primer.

(4) Clean, lint-free cotton cloths.

(5) New insulator(s) to replace damaged insulation. (Refer to R-3825-4 to obtain appropriate insulator part number.)

(6) Zinc chromate sealer (W. P. Fuller Paint Co), 3/16 inch thick by 3/8 inch wide, long enough to seal vacuum adapter to vacuum bag and vacuum bag around component or portion of component being repaired. Presstite tape 587.3 (Interchemical Corp) may be substituted for zinc chromate sealer to seal vacuum bag to component.

(7) Plastic bag, polyethylene, 6 mils thick (Polyfab Co) large enough to seal damaged area for applying vacuum.

(8) Hair-felt weatherstrip No. 97847 (Sears, Roebuck, and Co) and/or rubber bands to hold insulation in place. (Required only if repaired sections are large enough to require securing in place.)

(9) Vacuum adapter, No. 146023 (Rocketdyne).

(10) Portable vacuum pump, No. 54960 (Van Waters and Rogers, Inc.)

(11) Vacuum hose, 1/4 inch ID by 3/16 inch wall thickness, No. 56433 (Van Waters and Rogers, Inc.) long enough to interconnect component being repaired and vacuum pump.

(12) Toluene (Federal Specification TT-T-548).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

NOTE

The following instructions must be read completely before starting the repair procedure, to make sure the procedure is understood and to eliminate any delay once the repair is started.

c. Remove components or parts that hinder access to area to be repaired.

d. Using sharpened wooden or plastic scraper, carefully remove all damaged insulation.

e. Clean (paragraph 10-9) exposed metal surface.

WARNING

The following procedure specifies silicone primer RB0120-036, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

f. Apply a uniform brush coat of silicone primer to exposed metal surface. In areas inaccessible to brush, primer may be applied with clean, lint-free cotton cloth. All areas must be primed thoroughly to make sure adhesive bonds to surface. Allow one hour of drying time. Gently wipe off milky surface of primer until a clean, translucent film is obtained.

CAUTION

The pre-cast insulation is fragile and must be handled carefully to prevent damage.

g. Using care, dry-fit new or portion of new insulator to component being insulated.

h. Apply zinc chromate sealer or Presstite tape around component in an area that when plastic bag is sealed to it, it will make an airtight seal around damaged area.

i. Prepare adhesive (paragraph 10-10).

WARNING

The following procedure specifies adhesive RTV-560, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

j. Using sealant gun or spatula, apply catalyzed adhesive to inside surface of

insulator(s). When using bulk material, distribute adhesive with paintbrush having approximately one-inch bristles.

k. Install insulator(s) and if necessary secure in place using felt strips and/or rubber bands. Use felt strips to provide a path for vacuum to reach repair area.

l. Puncture small hole in plastic bag and install vacuum adapter.

m. Install plastic bag over repaired area and press bag opening into zinc chromate sealer or Presstite tape to seal area.

n. Apply zinc chromate sealer around vacuum adapter.

o. Attach hose from vacuum pump to vacuum tube fitting.

p. Turn on vacuum pump and push insulator(s into place as air is being evacuated from vacuum bag.

WARNING

Compressed gas must not be used for cooling unless effective chip guarding is used and personal protection equipment is worn.

q. Maintain vacuum noted in figure 10-1; then turn off vacuum pump. Monitor vacuum pump during operation for indication of overheating. If overheating occurs, cool pump with a fan or a flow of low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401).

Component	Vacuum Requirement (Inches Hg)
Electrical Control Assembly	15-25 for 24 hours.
Electrical Control Assembly Support Rod	6-10 for 24 hours.
Oxidizer Turbine By-Pass Valve	25-30 for 30 minutes; reduce to approximately 15 for 24 hours.

Figure 10-1. Vacuum Pressure Requirements for Insulating Components

r. Remove vacuum bag and equipment, and remove zinc chromate sealer, and if used, Presstite tape.

WARNING

Toluene is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

Cloth must not be soaked with toluene. Excess toluene destroys insulation and adhesive.

s. Using clean cloth dampened with toluene, clean adhesive from insulators.

10-9. Cleaning Surfaces.

a. Obtain the following equipment and materials, or their equivalents:

(1) Polyethylene sheet and masking tape as necessary to protect adjacent surfaces and components.

(2) Soft-bristle, stainless-steel brush.

(3) Short-bristle paintbrush, 2-inch, disposable.

(4) Trichloroethylene (MIL-T-27602).

(5) Clean, lint-free cotton cloths.

(6) Naphtha (Federal Specification TT-N-97). (Required only if hydraulic oil is to be removed.)

(7) Acetone (Federal Specification O-A-51). (Required only if naphtha (item 6) is used.)

(8) Cleaner Turco 4142 (Turco Products).

(9) Distilled or deionized water.

(10) Sharpened wooden or plastic scraper.

(11) Gaseous nitrogen (MIL-P-27401) or gaseous helium. (Refer to Volume I.)

(12) Small scrub brush.

b. Using plastic sheet and masking tape, protect any electrical wiring, nonmetallic surfaces, and components not being cleaned from cleaning chemicals.

c. Remove damaged insulation by scraping with a sharpened wooden or plastic scraper.

d. Perform steps e and f when cleaning thrust chamber tubes, hatbands, and support rings. Perform step g when cleaning other components.

e. Using soft-bristle, stainless-steel brush, remove remaining insulation and adhesive until clean bright metal is exposed.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

Extreme care must be used during cleaning procedures to prevent chemicals from coming in contact with surrounding insulation. Chemicals destroy insulation and adhesive.

f. Using short-bristle paintbrush and trichloroethylene, clean bright, exposed, metal surface.

g. Using clean lint-free cotton cloth dampened with trichloroethylene, clean surface. Repeat 2 times.

WARNING

Naphtha and acetone are flammable and must not be used near heat, sparks, or oper flame. They are toxic solvents. Inhalation of the vapors or prolonged contact with the liquid can cause serious injury.

- Using a stainless-steel brush with naphtha or acetone can cause ignition resulting in fire.

h. If there was evidence of hydraulic oil in areas to be repaired, clean area with lint-free, cotton cloth dampened with naphtha. Use acetone with clean, lint-free, cotton cloth, as required, to accelerate evaporation of naphtha. Repeat step g.

i. Mix 1/4 pound of Turco cleaner to 2-1/2 quarts of hot water to make an alkaline cleaning solution.

NOTE

Varying quantities of alkaline cleaning solution may be prepared, if the ratio of cleaner to water in step i is maintained.

j. Using clean, lint-free, cotton cloth or small scrub brush, clean area with alkaline solution until all traces of trichloroethylene are removed.

k. Using clean, lint-free, cotton cloth saturated with distilled or deionized water, clean area until all traces of alkaline solution are removed.

l. Perform a water-break test by spraying small amount of distilled or deionized water over cleaned area. An unbroken water film indicates area is clean. If water forms into small droplets, repeat steps f through l until an unbroken water film indicates that area is clean.

m. After water-break test, dry surface with gaseous nitrogen or helium.

10-10. Preparing Adhesive. The adhesive base material and catalyst are supplied in cartridges with slow curing catalyst and in preweighed (hand mixed) kits with either a slow or a fast curing catalyst. (See figure 10-2.) Before preparing an adhesive for use, a test mix must be prepared and tested. If the test mix is acceptable, a mix with the same lot number and void date must be used in the application of the insulation. Adhesive must not be prepared until directed in the applicable component insulation repair procedure. Read the procedure completely; then prepare cartridge adhesives as outlined in steps b through d, and bulk adhesives as outlined in steps e through g.

a. See figure 10-3 for adhesive requirements for component to be repaired.

Adhesive Specification	Adhesive Cartridge	Catalyst	Cartridge or Kit Size	Pot Life (Minutes)
RB0120-029 (Slow Curing)				
Type I	SF-667-RTV560/9950	RTV-9950	8-ounce	60
Type II	SF-650-RTV560/9950	RTV-9950	6-ounce	60
Type III	---	RTV-9950	Bulk	60
Type IV	---	Thermolite 12 (Liquid)	Bulk	60
RB0120-033 (Fast Curing)				
Type IV	---	Nuocure 28 (Liquid)	Bulk	7-10

NOTE: RTV-560 adhesive base used in cartridge and hand-mixed (bulk).

Figure 10-2. Insulation Adhesives

Component	Insulation Adhesive
Electrical Control Assembly	(a)
Electrical Control Assembly Support Rod	(b)
Fast Shutdown Valve	(a)(b)(c)
Main Fuel Valve	(b)
Oxidizer Turbine Bypass Valve	(a)(c)
Oxidizer Turbopump Volute	(b)
Thrust Chamber Hat Band and Support Ring	(a)
Thrust Chamber Tubes	(a)

(a) Adhesive RB0120-029 (Rocketdyne) Types I, II, or III.
(b) Adhesive RB0120-033 (Rocketdyne) Type IV.
(c) Adhesive RB0120-029 (Rocketdyne) Type IV.

Figure 10-3. Component Insulation Adhesive

b. If available, obtain a Semkit portable electrical mixer 285 (Products Research and Chemical, Semco) or equivalent. (Use of electrical mixer is optional and is not required for preparing cartridge adhesives.)

WARNING

The following procedure specifies an adhesive, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

c Test-mix adhesive cartridge as follows:

(1) Check lot number and void date to make sure shelf life has not expired.

(2) Precondition cartridge adhesive at a temperature of 100 ±10°F for 24 hours; then maintain temperature at 86 ±14°F. On cartridges with separate (screw-on type) dasher rod, it is necessary to precondition only the dasher rod.

(3) Pull dasher rod out approximately halfway.

(4) Insert ramrod into hole in top of dasher rod. Push ramrod until it hits bottom. (This injects catalyst into adhesive base material.) Adhesive is usable for approximately 60 minutes after mixing.

(5) Remove and discard ramrod.

(6) Mix catalyst into base material by stroking 25-30 complete strokes, turning dasher clockwise twice on each inward and outward movement. If Semkit portable electrical mixer is used, mix catalyst into base material by pushing end of dasher onto end of spindle. Adjust timer to operate 3/4 to one minute, and stroke cartridge up and down until timer stops.

(7) Pull dasher rod out to fully extended position, and unscrew dasher rod (approximately 3 turns) while gripping cartridge in area of dasher.

(8) Remove and discard dasher rod and bottom cap.

(9) Place mixed contents of cartridge into an open container.

(10) Inspect test sample 1-1/2 to 2-1/2 hours after mixed contents are placed in open container by attempting to groove surface of adhesive in several places. If surface cannot be grooved or if surface is grooved and adhesive does not refill grooves, adhesive is acceptable; proceed to step d. If adhesive continues to refill grooves, adhesive is unacceptable. Contact Rocketdyne Representative if adhesive is unacceptable.

d. Prepare adhesive cartridge for installing insulation as outlined in step c, substeps 1 through 8. Make sure cartridge is from same lot number as used for the acceptable test mix.

e. Obtain the following equipment and materials, or their equivalents for preparing bulk adhesive:

(1) Metal, glass, or other nonabsorbing container to mix approximately 25 grams of adhesive.

(2) Neoprene gloves.

(3) Six-inch stainless-steel spatula to mix adhesive.

WARNING

The following procedure specifies catalysts, which by themselves or when mixed with adhesive base, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling material. In case of contact, flush eyes with water for at least 15 minutes; wash skin with soap and water; and get medical attention.

f. Mix bulk adhesive as follows:

(1) Check lot number and void date to make sure shelf life has not expired.

(2) Precondition slow-curing catalyst RTV-9950 (General Electric) or Thermolite 12 (M&T Chemicals, Inc) at a temperature of 100° ±10° F for 24 hours; then maintain temperature at 86° ±14° F.

(3) Place a 20-gram lot of adhesive base RTV-560 in a glass, metal, or nonabsorbing container. Wear neoprene gloves when working with adhesive or catalyst.

(4) Add 2 grams of paste catalyst RTV-9950 or one drop of Thermolite 12 (slow-curing adhesive) or 3 drops of Nuocure 28 (fast-curing adhesive). Use an eyedropper to add liquid catalyst.

(5) Proceed to substep 6 if test-mixing a slow curing adhesive, and to substep 8 if test-mixing a fast curing adhesive.

(6) Using 6-inch stainless-steel spatula, carefully stir components together. Thorough mixing should take place in less than 6 minutes.

(7) Inspect test sample 1-1/2 to 2-1/2 hours after substep 4 by attempting to groove surface of adhesive in several places. If surface cannot be grooved or if surface is grooved and adhesive does not refill grooves, adhesive is acceptable; proceed to step g. If adhesive continues to refill grooves, adhesive is unacceptable. If adhesive is unacceptable, increase the amount of catalyst in increments of 1/2-gram paste catalyst or one-drop liquid catalyst. Repeat substeps 3, 6, and 7 until mixture is acceptable. Record mixture ratio.

(8) Using 6-inch stainless-steel spatula, carefully stir components together. Record time when reaction occurs (mixture can no longer be stirred). Reaction must occur within 7-10 minutes for an acceptable mixture ratio. Increase or decrease the amount of catalyst, and repeat steps 4 and 8 until reaction occurs within specified time. Change amount of liquid catalyst in one drop increments. Increasing the amount of catalyst decreases reaction time.

(9) Record mixture ratio determined in substep 8.

g. Prepare a 50-100 gram hand-mixed adhesive for installing insulation, as outlined in step f. Make sure materials are from same lot number as used in test mix. Slow curing adhesive must be thoroughly mixed within 6 minutes, and fast curing adhesive within 3 minutes. Use mixture ratio recorded in step f for fast curing adhesive.

NOTE

Varying quantities, as required by the installation, may be prepared if the mixture ratio is maintained.

10-11. ELECTRICAL CONTROL ASSEMBLY SUPPORT ROD.

10-12. The electrical control assembly support rod installation is pre-cast, silicone-base foam.

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-7.

c. Repair damage that exceeds limits of step b as outlined in remainder of this paragraph.

d. Remove support rod.

e. Repair insulation as outlined in paragraph 10-8.

f. Remove protective film from surface of new insulation section.

g. Reinstall support rod. Tighten nuts until a 0.002 inch gap exists between nut and spacer. If interference occurs between support rod and helium regulator supply line, insulation may be compressed to obtain clearance.

10-13. FAST-SHUTDOWN VALVE.

10-14. The fast shutdown valve insulation is pre-cast, silicone-base foam.

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-7.

c. Repair damage that exceeds limits of step b as outlined in remainder of this paragraph.

d. Obtain the following equipment and materials, or their equivalents.

(1) Nylon webbing strap 209744 (Rocketdyne).

(2) Buckles AVB-4 (FMC Corp).

(3) Toluene (Federal Specification TT-T-548).

(4) Insulator(s) 146052 or 146053 (Rocketdyne), as required.

(5) Sharpened wooden or plastic scraper for removing damaged insulation and adhesive.

(6) Silicone primer RB0120-036 (Rocketdyne).

(7) Paintbrush to apply primer to metal surfaces.

(8) Clean, lint-free cotton cloths.

e. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

NOTE

The following instructions must be read completely before starting the repair procedure to make sure the procedure is understood and to eliminate any delay once the repair is started.

f. Using sharpened wooden or plastic scraper, carefully remove damaged insulation.

g. Clean (paragraph 10-7) exposed metal surface.

WARNING

The following procedure specifies silicone primer RB0120-036, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

h. Apply a uniform brush coat of silicone primer to exposed metal surface. In areas inaccessible to brush, primer may be applied with clean, lint-free cotton cloth. All areas must be primed thoroughly to make sure adhesive bonds to surface. Allow one hour drying time. Gently wipe off milky surface of primer until a clean, translucent film is obtained.

CAUTION

The pre-cast insulation is fragile and must be handled carefully to prevent damage.

i. Carefully dry-fit new insulator section, or portion of section, to fast-shutdown valve. Trim insulator 146052 to clear cutout for lockwire. It may be necessary to split insulator 146053 for installation.

j. Prepare adhesive (paragraph 10-10). Use slow-curing adhesive. Fast-curing adhesive may be used where repair consists of installing one or part of one insulation segment.

WARNING

The following procedure specifies an adhesive, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

k. Apply adhesive to inside surface of insulator(s). Install insulators and apply hand pressure to initiate adhesion of insulation.

l. Install nylon webbing strap 209744 and buckle AVB-4 around insulator segments and pull strap handtight.

m. After insulation is installed, environment must remain at 70° to 100° F for a minimum of 8 hours for initial curing cycle; however, leave nylon strap in place for a minimum of 24 hours to allow complete curing of adhesive.

n. Relieve clamping action of buckle AVB-4 by bending with pliers. Remove strap 209744 and discard.

o. Remove protective film from surface of insulator repair area.

WARNING

The following procedure uses toluene which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

Cloth must not be soaked with toluene. Excess toluene destroys insulation and adhesive.

p. Using clean cloth dampened with toluene, clean adhesive from fast-shutdown valve insulators.

10-15. FUEL BLEED LINE.

10-16. The fuel bleed line insulation is polyurethane foam. Repair is limited to cracks, gouges, or cuts less than 1/8 inch deep, 1/8 inch wide, and 4 inches long. Repair damage within these limits as outlined in paragraph 10-17. For damage in excess of these limits, notify Rocketdyne Representative.

10-17. REPAIRING FOAM INSULATION.

a. Obtain the following material and equipment, or their equivalents:

(1) Vaporproof barrier material (MIL-B-131).

(2) Masking tape (Federal Specification UU-T-106).

(3) Toluene (Federal Specification TT-T-548).

(4) Lint-free cotton cloth.

(5) Sandpaper, No. 60 grit.

(6) If high pressure fuel duct or fuel bleed line insulation is to be repaired, red sealant RTV106 (General Electric). (Make sure storage life of sealant specified on container has not been exceeded.)

(7) If thrust chamber jacket purge line insulation is to be repaired, black sealant RTV103 (General Electric), or aerospace sealant DC92-018 (Dow Corning Corp). (Make sure storage life of sealant specified on container has not been exceeded.)

(8) Spatula to apply and smooth sealant.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Sand damaged area.

WARNING

Nylon cloth must not be used, since toluene is flammable and the nylon may generate static electrical sparks and ignite toluene vapors.

- Toluene is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

d. Clean damaged area with clean, lint-free cloth dampened with toluene.

WARNING

The following procedure specifies sealants, which are flammable and must not be used near heat, sparks, or open flame. They are toxic. Inhalation of their vapors or prolonged contact with the sealants can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

e. On fuel high pressure duct or fuel bleed line, apply red sealant to damaged area and smooth with a spatula to original contour of duct or line. (Sealant working life is approximately 30 minutes.)

f. On thrust chamber jacket purge line (helium chill line), apply black sealant or aerospace sealant to damaged area and smooth with a spatula to original contour of line. (Sealant working life is approximately 30 minutes.)

g. Remove excess material with cloth dampened with toluene.

h. Allow repaired area to cure at room temperature for 24 hours. Repair must be tack-free. If repair is still tacky, remove material with toluene and repeat repair procedure.

10-18. FUEL HIGH PRESSURE DUCT.

10-19. The fuel high pressure duct insulation is polyurethane foam. Repair is limited to cracks, gouges, or cuts less than 1/8 inch deep, 1/8 inch wide, and 4 inches long. Repair damage within these limits as outlined in paragraph 10-17. For damage in excess of these limits, notify Rocketdyne Representative.

10-20. FUEL TURBINE EXHAUST DUCT.

10-21. The fuel turbine exhaust duct insulation is heat-dissipating black fluorelastomer. Damage consisting of scratches or is confined to areas less than 1/2 square foot is repaired as outlined in paragraph 10-22. Insulation damage that exceeds 1/2 square foot is repaired as outlined in paragraph 10-23.

10-22. MINOR REPAIR.

a. Obtain the following equipment and materials, or their equivalents:

(1) D-4327 coating (Dyna-Therm Corp).

(2) No. 2 Zahn viscosimeter.

(3) One to 1-1/2 inch natural-bristle artist brush.

(4) Methyl-isobutyl-ketone (Federal Specification (TT-M-268). (Required only if coating D-4327 requires thinning.)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

The following procedure specifies methyl-isobutyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

- The following procedure specifies coating D-4327, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the coating can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

c. Using No. 2 Zahn viscosimeter, check viscosity of coating. Viscosity of 60-120 seconds is acceptable. Dilute coating with methyl-isobutyl-ketone (TT-M-268) if necessary.

d. Using brush, apply coating, brushing in one direction only.

e. Allow coating to air dry 24 hours before handling.

10-23. MAJOR REPAIR.

a. Obtain the following equipment and materials, or their equivalents:

(1) Coating D-4327 (Dyna-Therm Corp).

(2) Artist brush, one to 1-1/2 inches, natural bristle.

(3) Aluminum cleaner Turco 4142, (Turco Products).

(4) Clean, line-free cloth.

(5) Distilled or deionized water.

(6) Wire brush SS-15 or SS-46 (Gordon Brush Co). (Required only if corrosion is encountered.)

(7) Methyl-ethyl-ketone (Federal Specification TT-M-261).

(8) Gaseous nitrogen (MIL-P-27401) or gaseous helium. (Refer to R-3825-3, Volume I.)

(9) Methyl-isobutyl-ketone (Federal Specification TT-M-268). (Required only if coating D-4327 requires thinning.)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

WARNING

The following procedure uses methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

c. Using clean, lint-free cloth moistened with methyl-ethyl tone, clean damaged coating and surface until surface metal is exposed. If surface metal has evidence of corrosion, wire-brush surface until bright metal surface appears.

d. Mix 1/4 pound of aluminum cleaner Turco 4142 with 2-1/2 quarts of hot water to make an alkaline cleaning solution.

NOTE

Varying quantities of alkaline cleaning solution may be prepared if the ratio of cleaner to water in step d is maintained.

e. Using clean, lint-free cloth, clean area with alkaline solution until all traces of methyl-ethyl-ketone are removed.

f. Using clean, lint-free cloth saturated with distilled water, clean area until all traces of alkaline solution are removed.

g. Perform a water-break test by pouring a small amount of distilled or deionized water over cleaned area. An unbroken water film indicates area is clean. If water forms into small droplets, repeat steps e through g until water film indicates that area is clean.

h. After water-break test, dry surface with gaseous nitrogen or helium.

WARNING

The following procedure specifies coating D-4327, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the coating can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

i. Agitate coating D-4327 for 3-5 minutes.

WARNING

The following procedure uses methyl-isobutyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

j. Using No. 2 Zahn viscosimeter, check viscosity of coating. Viscosity of 60-120 seconds is acceptable. Dilute coating with methyl-isobutyl-ketone (TT-M-268) if necessary.

k. Using brush, apply coating, brushing in one direction only.

l. Allow coating to air dry 24 hours before handling.

10-24. HEAT EXCHANGER INLET TUBE.

10-25. The heat exchanger inlet tube insulation is Micro-Fibre. Repair this insulation as outlined in paragraph 10-26.

10-26. REPAIRING MICRO-FIBRE INSULATION. Repair of Micro-Fibre insulation consists of taping cut or split insulation or covering (paragraph 10-27), filling crushed or damaged areas that constitute 1/3 or less of the total insulation area (paragraph 10-28), or repairing crushed or damaged areas that exceed 1/3 of the total area or are wet or contaminated with hydraulic oil (paragraph 10-29). Except as noted, the following equipment and materials, or their equivalents are required:

a. Micro-Fibre felt, Type E or 475 (4 ±1 lb/cu ft) (Johns-Manville Products). (Not required for paragraph 10-27 repair.)

b. Tape, aluminum, pressure-sensitive, (Minnesota Mining and Mfg). (One- or 2-inch wide as appropriate.)

c. Knife. To cut tape and insulation. (Not required for paragraph 10-27 repair.)

d. Trichloroethylene (MIL-T-27602). (Required only if area to be repaired is soiled.)

e. Clean, lint-free cloth. (Required only if area to be repaired is soiled.)

f. Tying tape RH0150-026 (Rocketdyne). (Not required for paragraph 10-27 or 10-28 repair.)

g. White sealant RTV-102 (General Electric).

10-27. Repairing Cut and/or Split Insulation or Insulation Covering.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

a. If exterior taped surface is soiled, clean surface with clean, lint-free cloth dampened with trichloroethylene. Allow surface to dry thoroughly.

b. Apply strip of aluminum tape over damaged area, overlapping each side of cut a minimum of 1/2 inch, or wrap tape around circumference of component, overlapping tape a minimum of 1/2 inch until damaged area is covered. Wrap tape with a minimum of tension to prevent compressing insulation.

WARNING

The following procedure specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

c. Seal wrinkled edges of tape with white sealant.

10-28. Repairing Damaged Insulation (Less Than 1/3 of Insulation Area Damaged).

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

a. If exterior taped surface is soiled, clean surface with clean, lint-free cloth dampened with trichloroethylene. Allow surface to dry thoroughly.

b. Place sheet of insulation on a plywood board, or equivalent. Using sharp knife, cut enough insulation to match and fill crushed or damaged area.

c. Fill crushed or damaged area with insulation.

d. Wrap aluminum tape around circumference of component, overlapping tape a minimum of 1/2 inch until crushed or damaged area is covered. Wrap tape with a minimum of tension to prevent compressing insulation.

WARNING

The following procedure specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

e. Seal wrinkled edges of tape with white sealant.

10-29. Repairing Damaged Insulation (Greater Than 1/3 of Insulation Area Damaged).

a. Using sharp knife, cut entire length of tape. Remove tape and first layer of insulation. Remove second layer of insulation if damaged. If both layers are removed, take extreme care to prevent damaging component.

b. Using sharp knife, trim Micro-Fibre insulation on adjacent component if insulated. Take extreme care to prevent damaging component.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

c. If surface of component is exposed, clean surface using clean, lint-free cloth dampened with trichloroethylene. Allow surface to dry thoroughly.

d. Place sheet of insulation on a plywood board, or equivalent. Using sharp knife, cut insulation to replace removed insulation. Trim or cut insulation as required to ensure access to leak test ports.

e. Install insulation (one or 2 layers) on component, butting new insulation against insulation on adjacent component, if existing. Secure insulation with tying tape.

f. Cover insulation with aluminum tape. Overlap tape approximately 1/2 inch, including tape on adjacent component, if existing. Wrap tape with a minimum of tension to prevent compressing insulation.

WARNING

The following procedure specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

g. Seal wrinkled edges of tape with white sealant.

10-30. INTEGRAL HYDROGEN-HELIUM START TANK.

10-31. Refer to section XI for repair of the integral hydrogen-helium start tank insulation.

10-32. MAIN FUEL VALVE.

10-33 The main fuel valve insulation is precast, silicone base foam.

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-7.

c. Repair damage that exceeds limits of step b as outlined in remainder of this paragraph.

d. Obtain the following equipment and materials, or their equivalents:

(1) Sharpened wooden or plastic scraper to remove damaged insulation.

(2) New insulator(s) to replace damaged insulation. (Refer to R-3825-4 to obtain appropriate insulator part number.)

(3) Strap, nylon webbing, 209744 (Rocketdyne).

(4) Buckle AVB-4 (American Viscose Division, FMC).

(5) Toluene (Federal Specification TT-T-548).

(6) Silicone primer RB0120-036 (Rocketdyne).

(7) Paintbrush to apply primer.

(8) Clean, lint-free cotton cloths.

e. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

f. Remove components or parts that hinder access to area to be repaired.

g. Using sharpened wooden or plastic scraper, carefully remove damaged insulation.

h. Clean (paragraph 10-9) exposed metal surface.

WARNING

The following procedure specifies silicone primer RB0120-036, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

i. Apply a uniform brush coat of silicone primer to exposed metal surface. In areas inaccessible to brush, primer may be applied with clean, lint-free cotton cloth. All areas must be primed thoroughly to make sure adhesive bonds to surface. Allow one hour drying time. Gently wipe off milky surface of primer until a clean, translucent film is obtained.

CAUTION

The pre-cast insulation is fragile and must be handled carefully to prevent damage.

j. Using care, dry-fit new insulator section, or portion of section, to main fuel valve.

k. Prepare adhesive (paragraph 10-10).

WARNING

The following procedure specifies an adhesive, which when mixed with catalyst must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

l. Using sealant gun or spatula, apply catalyzed adhesive to inside surface of insulator(s). When using bulk material, distribute adhesive with paintbrush having approximately one-inch bristles.

m. Do not remove protective film from exterior surface of insulator(s) at this time.

n. Install insulator(s). Apply hand pressure to initiate adhesion of insulator(s) to main fuel valve.

o. Install strap 209744 and buckle AVB-4 around main fuel valve. Handtighten only.

p. Following installation of insulation, environment must remain at 72° to 100° F for a minimum of 24 hours to allow complete curing of adhesive.

q. Relieve clamping action of buckle AVB-4 by bending with pliers. Remove straps 209744 and discard.

r. Reinstall any previously removed components or parts.

s. Remove protective film from surface of insulator(s).

WARNING

Toluene is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can result in serious injury or death.

CAUTION

Cloth must not be soaked with toluene. Excess toluene destroys insulation and adhesive.

t. Using clean cloth dampened with toluene, clean adhesive from insulators.

10-34. MIXTURE RATIO CONTROL VALVE.

10-35. The mixture ratio control valve insulation is Micro-Fibre. Repair this insulation as outlined in paragraph 10-26.

10-36. OXIDIZER BLEED LINE.

10-37. The oxidizer bleed line insulation is Micro-Fibre. Repair this insulation as outlined in paragraph 10-26.

10-38. OXIDIZER BLEED VALVE.

10-39. The oxidizer bleed valve insulation is Micro-Fibre. Repair this insulation as outlined in paragraph 10-26.

10-40. OXIDIZER HIGH PRESSURE DUCT.

10-41. The insulation on the oxidizer high pressure duct lower elbow and between the upper elbow and the MOV is Micro-Fibre. The remaining insulation is polyurethane foam. Repair Micro-Fibre insulation as outlined in paragraph 10-26. Repair polyurethane foam insulation (see figure 10-4) as follows:

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-17.

c. Repair damage that exceeds limits of step b by replacing the damaged insulator(s) as outlined in remainder of this paragraph.

d. Obtain the following equipment and materials, or their equivalents:

(1) Sharp knife to remove damaged insulator(s).

(2) Abrasive cloth, 40 grit.

(3) Soft-bristle brush to remove loose particles.

(4) White sealant RTV-102 (General Electric).

(5) New insulator(s) to replace damaged insulation. (Refer to R-3825-4 for insulator part numbers.)

(6) Strap, nylon webbing, 209744-25 (Rocketdyne) and buckle AVB-4 (American Viscose Division, FMC). (Required only if clamping in addition to clamping provided by straps on duct is required to replace damaged insulator(s).)

(7) External coating RB0120-030 (Rocketdyne).

e. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

f. Remove components or parts that hinder access to area to be repaired including strap(s) that secure insulation.

g. Using sharp knife, carefully cut existing adhesive bond joint and remove damaged insulator. To improve repair, slightly undercut adjoining insulator.

h. Using abrasive cloth, abrade rough edges of existing insulator(s) at cut-out area.

i. Using soft-bristle brush, brush cut-out area to remove loose particles.

j. Dry-fit new insulator(s).

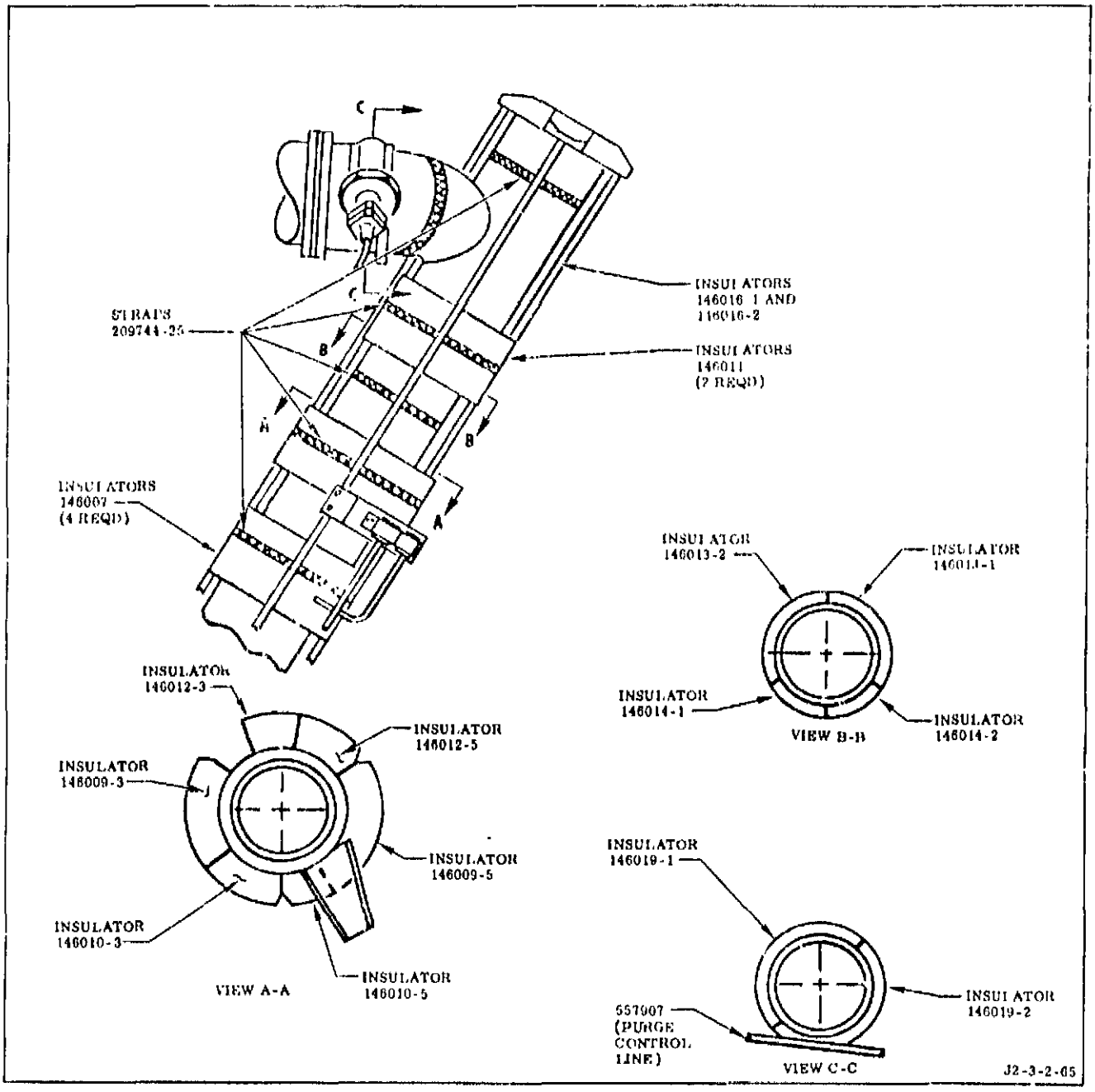


Figure 10-4. Oxidizer High Pressure Duct Polyurethane Insulation

NOTE

A broken insulator may be used if it is not broken in more than two pieces.

k. If damage was extensive install new insulation in the following sequence:

(1) 146016-1 and 146016-2

(2) 146019-1 and 146019-2

(3) 146013-1, 146013-2, 146014-1, and 146014-2.

(4) Four insulators 146007.

(5) 146009-3, 146012-3, 146012-5, 146009-5, 146010-3, and 146010-5.

WARNING

The following procedure specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

l. Apply an even coat of white sealant to mating surface of each insulator(s). Apply an even coat of sealant to any broken surfaces of insulator(s).

m. Secure insulator(s) with strap 209741-25 and buckle AVB-4. Pull strap handtight.

n. Install strap and buckle longitudinally over insulators 146019-1 and 146019-2 and around insulators 146016-1 and 146016-2, and handtighten strap to hold insulators as close as possible.

o. Fill any gap between insulators on upper portion of oxidizer high pressure duct as follows:

(1) Gaps smaller than 3/8 inch can be filled by shifting insulators to divide the gap in two; then filling the two smaller gaps with white sealant.

(2) Gaps larger than 3/8 inch must be filled by cutting a segment from a spare insulator with a sharp knife or equivalent tool. Install segment in place using white sealant.

p. If insulation is not complete on flange area of oxidizer high pressure duct, complete insulation of flange as follows:

(1) Obtain polyurethane foam material of similar thickness and contour from field site supplies.

(2) Trim material, as necessary, to fit area of high pressure duct flange to be insulated.

(3) Install fitted insulation in place using white sealant.

q. Fill all mating joints of insulators with white sealant. Fill joints flush with surface of insulation.

r. Fill area between insulation and flanges with white sealant.

s. Coat exposed insulation with external coating.

t. Allow adhesive to cure 24 hours.

u. After adhesive has cured, remove excess straps leaving only straps shown in figure 10-4.

10-42. OXIDIZER INLET DUCT.

10-43. The oxidizer inlet duct insulation is polyurethane foam.

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-17.

c. Repair damage that exceeds limits of step b by replacing the damaged insulator(s) as outlined in remainder of this paragraph.

d. Obtain the following equipment and materials, or their equivalents:

(1) Sharp knife to remove damaged insulator(s).

(2) Abrasive cloth, 40 grit.

(3) Soft bristle brush to remove loose particles.

(4) White sealant RTV-102 (General Electric).

(5) New insulator(s) to replace damaged insulation. (Refer to R-3825-4 for insulator part numbers.)

(6) Strap, nylon webbing, 209744-27 (Rocketdyne) and buckle AVB-4 (American Viscose Division, FMC). (Required only if clamping in addition to clamping provided by straps on duct is required to install damaged insulator(s).)

(7) Spatula, stainless-steel to remove excess sealant.

e. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

f. Remove components or parts that hinder access to area to be repaired including strap(s) that secure insulation.

g. Using sharp knife, carefully cut existing adhesive bond joint and remove damaged insulator. To improve repair, slightly undercut adjoining insulator.

h. Using abrasive cloth, abrade rough edges of existing insulator(s) at cut-out area.

i. Using soft-bristle brush, brush cut-out area to remove loose particles.

WARNING

The following procedure specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

CAUTION

Whenever this procedure requires the application of white sealant, use only enough sealant to bond joint. If excessive sealant is used, it can be forced from the bond joint when the strap is tightened, creating a bead on either or both sides of insulation that could cause binding during gimbaling.

j. Dry-fit and install insulator(s) 146003-3 and/or 146003-5 around each bellows section of the oxidizer inlet duct (see figure 10-5) as follows:

NOTE

A broken insulator(s) may be used if it is not broken in more than two pieces.

(1) Using sharp knife or abrasive cloth, trim ends of insulator(s) 146003-5 as necessary, to obtain a clearance of approximately 0.125 inch between bellows and insulator. Trim an even amount of material from each end of insulator, to prevent possible binding.

(2) Repeat substep 1, to obtain same fit for insulator(s) 146003-3.

(3) Install insulator(s) on bellows.

(4) Apply an even coat of white sealant to any broken surfaces of insulator(s).

(5) Apply an even coat of white sealant to mating surfaces of insulators. Secure with strap 209744-27 and buckle AVB-4. Pull strap handtight.

k. Dry-fit and install insulator(s) 146004 (see figure 10-5) as follows:

(1) Using sharp knife or abrasive cloth, trim one end of insulator(s), as required, to obtain clearance of approximately 0.090 inch to insulators 146004 and 146003-5. If more than one insulator is being installed, trim an equal amount from each insulator end shown in figure 10-5.

(2) Apply an even coat of white sealant to mating surfaces of insulators. Install insulator(s) around center flange of inlet duct and secure with strap 209744-27 and buckle AVB-4. Pull strap handtight.

l. Dry-fit and install insulator(s) 146005, 146005-3, and/or 146005-5 (see figure 10-5) as follows:

(1) Using sharp knife or abrasive cloth, trim one end of insulator(s), as required, to obtain clearance of approximately 0.090 inch to insulators 146003-3. If more than one insulator is being installed, trim an equal amount from each insulator end shown in figure 10-5.

(2) Apply an even coat of white sealant to mating surfaces of insulators. Install insulator(s) (see figure 10-5) and secure with strap 209744-27 and buckle AVB-4. Pull strap handtight.

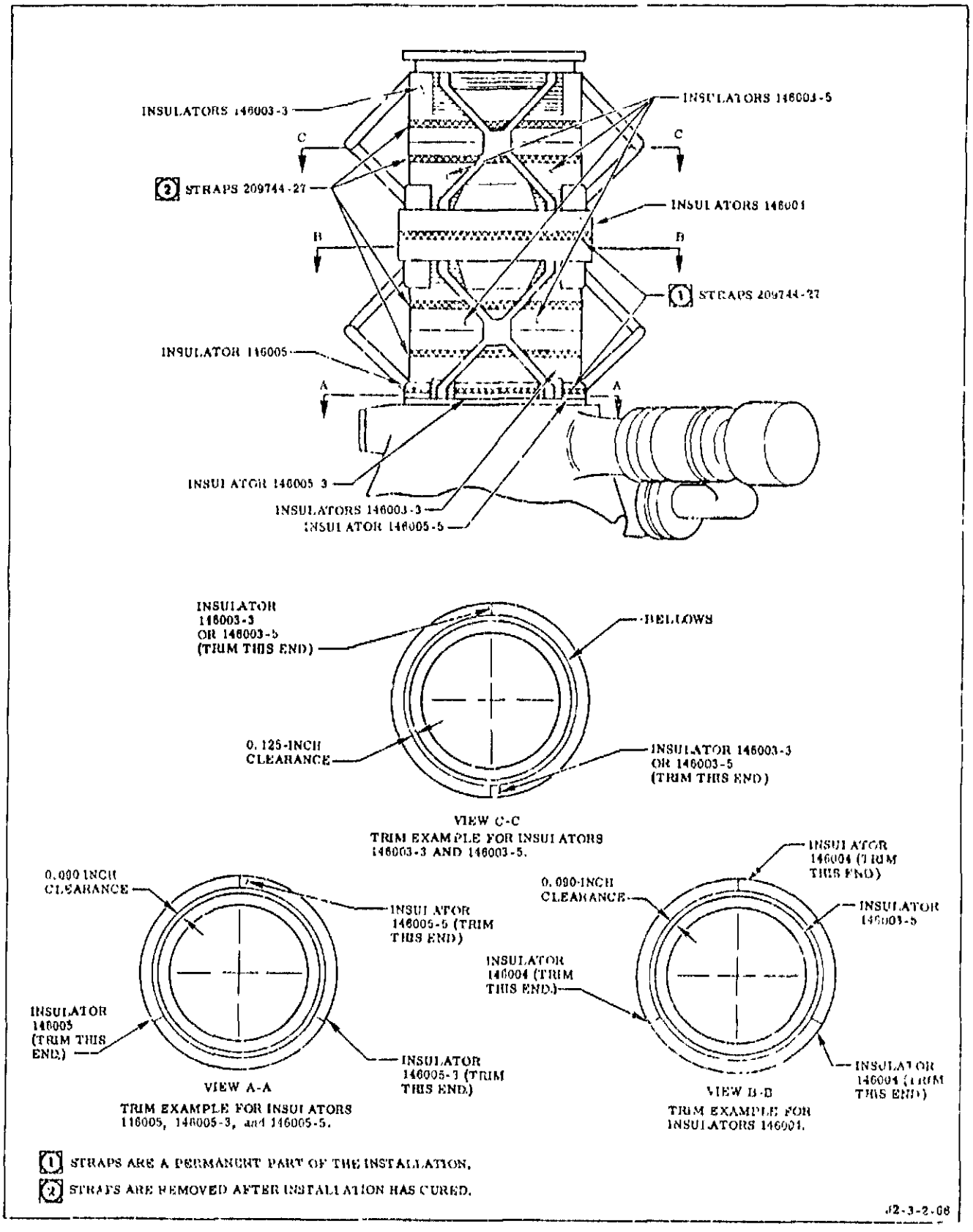


Figure 10-5. Oxidizer Inlet Duct Insulation

m. Fill all bonded joints of insulators with white sealant. Fill joints flush with surface of insulation.

n. Using a thin, flexible object, such as narrow stainless-steel spatula, remove any adhesive that may prevent free movement of insulators during gimbaling.

o. Allow adhesive to cure 24 hours.

p. After adhesive has cured, remove excess straps, leaving only straps shown in figure 10-5.

10-44. OXIDIZER TURBINE.

10-45. The insulation is Micro-Fibre. Repair this insulation as outlined in paragraph 10-26.

10-46. OXIDIZER TURBINE BYPASS VALVE.

10-47. The oxidizer turbine bypass valve insulation is pre-cast, silicone-base foam.

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-7.

c. Repair damage that exceeds limits of step b as outlined in paragraph 10-8, except on insulator 146054-7, do not apply adhesive on surface that mates with side of vent port relief valve. Make sure surface around centerhole has a coat of adhesive, to provide a vapor seal.

10-48. OXIDIZER TURBOPUMP PUMP MOUNTS.

10-49. The insulation is Micro-Fibre. Repair this insulation as outlined in paragraph 10-26.

10-50. OXIDIZER TURBOPUMP VOLUTE.

10-51. The oxidizer turbopump volute insulation is pre-cast, silicone base foam.

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-7.

c. Repair damage that exceeds limits of step b as outlined in remainder of this paragraph.

d. Obtain the following equipment and materials, or their equivalents:

(1) Sharpened wooden or plastic scraper for removing damaged insulation.

(2) Silicone primer RB0120-036 (Rocketdyne).

(3) Natural-bristle paintbrush, 2-inch, disposable.

(4) Clean, lint-free cloths.

(5) New insulator(s) to replace damaged insulation. (Refer to R-3825-4 for insulator part numbers.)

(6) Toluene (Federal Specification TT-T-548).

(7) Silicone-base foam and catalyst RB0130-068 (Rocketdyne).

(8) Sharp knife.

(9) Sandpaper, No. 80 grit.

(10) Gaseous nitrogen or helium. (Required only if desired to remove loose particles by blowing rather than brushing.)

(11) Spatula, stainless steel, 6-inch blade.

(12) External coating RB0120-030 (Rocketdyne).

e. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

f. If necessary, disconnect clamp assemblies securing oxidizer bleed line and harness assemblies to allow enough movement of the line and harness to install insulation.

g. Using sharpened wooden or plastic scraper, carefully remove damaged insulation.

h. Clean (paragraph 10-9) exposed metal surface.

WARNING

The following procedure specifies silicone primer RB0120-036, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

i. Apply a uniform brush coat of silicone primer to exposed metal surface. In areas inaccessible to brush, primer may be applied with clean, lint-free cotton cloth. All areas must be primed thoroughly to make sure adhesive bonds to surface. Allow one hour drying time. Gently wipe off milky surface of primer until a clean, translucent film is obtained.

CAUTION

The pre-cast insulation is fragile and must be handled carefully to prevent damage.

j. Using care, dry-fit new or portion of new insulator, observing the following:

(1) On insulator 146002-5, it may be necessary to split insulator to allow radii of insulator and volute mounting pad to contact each other.

(2) On insulators 146002-13 or 146002-17, make sure radii of insulator(s) and MRCV valve mounting pad make contact.

k. Prepare adhesive (paragraph 10-10).

WARNING

The following procedure specifies silicone base foam and catalyst RB0130-068, which may irritate skin. Protective clothing must be worn when handling material. In case of contact, wash skin with soap and water.

l. Spread adhesive smoothly over entire inside surface of insulator.

m. Immediately reinstall adhesive-coated insulator in original position, and apply hand pressure to initiate adhesion of insulation to volute surface. Adhesive must be applied and insulator reinstalled as quickly as possible. Insulator will not adhere to surface of volute if adhesive has started to set.

n. Apply adhesive to joints between edges of insulation and volute flanges and into areas where insulation is not adhering to volute.

WARNING

Toluene is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

Cloth must not be soaked with toluene. Excess toluene destroys insulation and adhesive.

o. Following installation of insulation, environment must remain at 72° to 100° F for a minimum of 8 hours for initial curing cycle. Allow insulation to cure for 24 hours, remove protective film, remove adhesive from surface of insulation using clean, lint-free cloth dampened with toluene. Clean by rubbing in one direction only and changing cloth frequently to ensure thorough cleaning. Do not allow toluene to penetrate between insulator joints.

p. Fill gaps and cavities in excess of 3/16 inch between insulators with silicone-base foam as follows:

(1) Wear neoprene gloves.

(2) Place foam on a piece of metal, glass, or a sheet of polyethylene. Flatten foam into thin, round shape.

(3) Pour half of catalyst over foam. Immediately knead material by hand. Flatten again and pour remainder of catalyst on foam, kneading it again. Complete kneading in one minute, since foaming and curing start immediately.

(4) Press foam material firmly into gaps or cavities. (Material continues to expand for 15-30 minutes.)

WARNING

Compressed gas must not be used unless effective chip guarding is used and personal protection equipment is worn.

(5) Allow material to cure 4 hours. Carefully trim off excess material with a sharp knife, and blend surface of surrounding area with sandpaper. After sanding, remove loose particles with low pressure (less than 30 psig) gaseous nitrogen or helium, or by brushing.

WARNING

The following procedure specifies external coating RB0120-030, which may irritate skin. Protective clothing must be worn when handling coating. In case of contact, wash skin with soap and water.

q. Using spatula, mix external coating by stirring one gram (53 drops) of catalyst into 160 grams of base coating at 80° F. (Mixture working life is 5-10 minutes.)

r. Apply coating in one direction only with natural-bristle paintbrush.

s. Allow coating to cure for at least 72 hours before handling.

t. Reinstall clamps and attaching hardware disconnected to step f.

10-52. THRUST CHAMBER HAT BAND AND SUPPORT RING.

10-53. The thrust chamber hat band and support ring insulation is pre-cast, silicone-base foam.

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-7.

c. Repair damage that exceeds limits of step b as outlined in remainder of this paragraph.

d. Obtain the following equipment and materials, or their equivalents:

(1) Sharpened wooden or plastic scraper for removing damaged insulation.

(2) Silicone primer RB0120-036 (Rocketdyne).

(3) Paintbrush to apply primer.

(4) Clean, lint-free cotton cloths.

(5) New insulator(s) to replace damaged insulation. (Refer to R-3825-4 to obtain appropriate insulator part number.)

(6) Zinc chromate sealer (W. P. Fuller Paint Co), 3/16 inch thick by 3/8 inch wide, and long enough to seal plastic sheet around thrust chamber. Presstite tape 587.3 (Interchemical Corp) may be substituted for zinc chromate sealer.

(7) Plastic sheet, polyethylene, 6 mils thick, and large enough to wrap thrust chamber and seal damaged area for vacuum application.

(8) Hair-felt weatherstrip No. 97847 (Sears, Roebuck, and Co) to pad sharp protrusions.

(9) Portable vacuum pump, No. 54960 (Van Waters and Rogers, Inc).

(10) Vacuum hose, 1/4 inch ID by 3/16 inch wall thickness, No. 56433 (Van Waters and Rogers, Inc) long enough to interconnect component being repaired and vacuum pump.

(11) Toluene (Federal Specification TT-T-548).

e. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

NOTE

The following instructions must be read completely before starting the repair procedure, to make sure the procedure is understood and to eliminate any delay once the repair is started.

f. Remove components or parts that hinder access to area to be repaired, including loosening drain lines as necessary to permit passing plastic sheet between thrust chamber and drain lines.

g. Using sharpened wooden or plastic scraper, carefully remove damaged insulation.

h Clean (paragraph 10-9) exposed metal surface.

WARNING

The following procedure specifies silicone primer RB0120-036, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

i. Apply a uniform brush coat of silicone primer to exposed metal surface. In areas inaccessible to brush, primer may be applied with clean, lint-free cotton cloth. All areas must be primed thoroughly to make sure adhesive bonds to surface. Allow one hour drying time. Gently wipe off milky surface of primer until a clear, translucent film is obtained.

CAUTION

The pre-cast insulation is fragile and must be handled carefully to prevent damage.

j. Using care, dry-fit new or portion of new insulator to thrust chamber. See figure 10-6 for location and identification of insulators.

NOTE

Hat bands No. 5 through No. 8 may be vacuum bagged individually or collectively.

- Support rings No. 2 through No. 4 must be vacuum bagged collectively because of the thrust chamber sling bracket.
- Support ring No. 1 may be vacuum bagged individually or collectively with support rings No. 2 through No. 4.

k. Apply Presstite tape to entire circumference of thrust chamber above and below repair area at the following locations, as applicable:

(1) Below support ring No. 1, on exit flange.

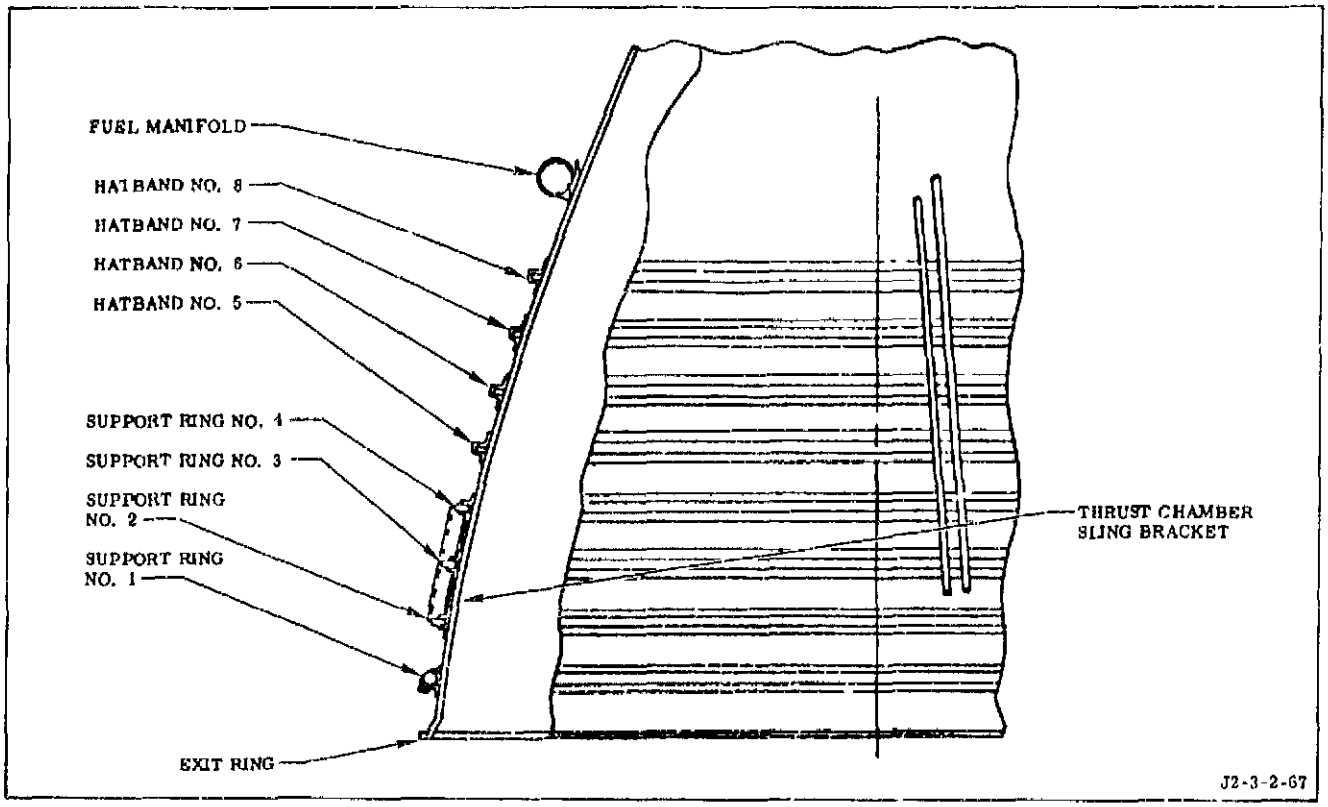
(2) Between support rings No. 1 and No. 2, directly on thrust chamber tubes.

(3) Between support ring No. 4 and hat band No. 5, directly on thrust chamber tubes.

(4) Between any hat bands, directly on thrust chamber tubes.

(5) Above hat band No. 8 to edge of fuel manifold or directly on thrust chamber tubes.

l. Wrap plastic sheeting around thrust chamber, over support rings or hat bands, and under overboard drain lines, taking approximately 2-inch tucks in lower edge as necessary to provide fullness in plastic sheeting.



Support Ring or Hat Band Number	Insulator Number
1	209738
2, 3, and 4	209740
5, 6, 7, and 8	209739

Figure 10-6. Thrust Chamber Hat Band and Support Ring Insulators

m. Seal lower edge of plastic sheeting to Presstite tape. Make sure to provide enough fullness for sheeting to mold over and around insulation and thrust chamber components. After sealing to Presstite tape, allow sheeting to fold or drop clear of support ring or hat band insulation that is being repaired. (A strap or tiecord must be used to support weight of sheeting.)

n. Prepare adhesive (paragraph 10-10).

WARNING

The following procedure specifies adhesive RTV-560, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

o. Using sealant gun or spatula, apply catalyzed adhesive to inside surface of insulator(s). When using bulk material, distribute adhesive with paintbrush having approximately one-inch bristles.

p. Do not remove protective film from exterior surface of insulator(s) at this time.

q. Immediately install adhesive-backed insulator(s) in original dry-fitted position. Apply hand pressure to initiate adhesion to thrust chamber hat band or support ring.

r. Tie a 3-inch-wide strip of plastic sheeting around support ring or hat band that is being repaired. Masking tape may be used to prevent plastic strip and repair material from slipping off support ring or hat band. Tighten only as necessary to keep repair segment from shifting. (Vacuum procedure will apply pressure needed to secure segment to support ring or hat band.

s. Tape felt or other material over any sharp corners, protrusions, or studs that might tear or puncture plastic sheet when vacuum is applied.

t. Raise plastic sheeting over support rings or hat bands, and seal sheeting to upper band of Presstite tape. Using additional Presstite tape, take tucks at intervals to take up excess slack, as necessary. Provide enough fullness for sheeting to be molded around each insulation segment and component (bracket, etc).

u. Insert end of vacuum hose under overlapped end of plastic sheeting, and apply additional Presstite tape to seal overlapped ends of sheeting and hose.

v. Connect vacuum hose to vacuum pump.

WARNING

Compressed gas must not be used for cooling unless effective chip guarding is used and personal protection equipment is worn.

w. Start vacuum pump, and regulate bleed valve to provide enough leakage to allow manipulation of plastic sheeting over insulation segments. Monitor vacuum pump for indication of overheating. If overheating occurs, cool pump with a fan or a flow of low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401).

CAUTION

Plastic sheeting must be loose enough over insulation segments and edges of segments to prevent being stretched. Excessive stretching of plastic sheet over insulation segments will cause insulation to crack.

x. Carefully arrange plastic sheeting to mold easily to insulation segments and into fillet areas at edge of segments, and position segments squarely on support rings or hat bands. Use tiecord (tied around thrust chamber) to support plastic sheeting where necessary.

y. Regulate bleed valve, as necessary, to increase gage (differential) pressure to 15-25 inches of mercury. Maintain this pressure for a minimum of 24-hour curing period.

z. Allow insulation to remain undisturbed during 24-hour (minimum) curing period; then turn off vacuum pump. Temperature must be stabilized at 72° to 100° F for the first 8 hours (minimum).

aa. Remove plastic sheeting, tape, felt strips, and Presstite tape from thrust chamber.

ab. Remove protective film from surface of each insulator.

WARNING

Toluene is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

Cloth must not be soaked with toluene. Excess toluene destroys insulation and adhesive.

ac. Using clean cloth dampened with toluene, clean adhesive from insulators.

10-54. THRUST CHAMBER JACKET PURGE LINE.

10-55. The thrust chamber jacket purge line insulation is silicone foam. Repair is limited to cracks, gouges, or cuts less than 1/8 inch deep, 1/8 inch wide, and 4 inches long. Repair damage within these limits as outlined in paragraph 10-17. For damage in excess of these limits, notify Rocketdyne Representative.

10-56. THRUST CHAMBER TUBES.

10-57. The thrust chamber tube insulation is pre-cast, silicone-base foam.

a. Repair nicks, scratches, and gouges less than 1/16 inch deep as outlined in paragraph 10-6.

b. Repair nicks, scratches, and gouges more than 1/16 inch deep but less than 1/3 the total surface of an insulator as outlined in paragraph 10-7.

c. Repair damage that exceeds limits of step b as outlined in remainder of this paragraph.

d. Obtain the following equipment and materials, or their equivalents:

(1) Sharpened wooden or plastic scraper for removing damaged insulation.

(2) Silicone primer RB0120-036 (Rocketdyne).

(3) Paintbrush to apply primer.

(4) Clean, lint-free cotton cloths.

(5) Pressure plates.

(6) Special rubber band, 1-1/2 inches wide by 240 inches long (L. A. Standard Rubber).

(7) Strap, nylon webbing, 209744 (Rocketdyne).

(8) Buckle AVB-4 (American Viscose Division, FMC).

(9) Tensioner AVT-11C (American Viscose Division, FMC).

(10) Toluene (Federal Specification TT-T-548).

e. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

NOTE

The following instructions must be read completely before starting the repair procedure, to make sure the procedure is understood and to eliminate any delay once the repair is started.

f. Remove components or parts that hinder access to area to be repaired.

g. Using sharpened wooden or plastic scraper, carefully remove damaged insulation.

h. Clean (paragraph 10-9) exposed metal surface.

WARNING

The following procedure specifies silicone primer RB0120-036, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

i. Apply a uniform brush coat of silicone primer to exposed metal surface. In areas inaccessible to brush, primer may be applied with clean, lint-free cotton cloth. All areas must be primed thoroughly to make sure adhesive bonds to surface. Allow one hour drying time. Gently wipe off milky surface of primer until a clean, translucent film is obtained.

CAUTION

The pre-cast insulation is fragile and must be handled carefully to prevent damage.

j. Using care, dry-fit new or portion of new insulator to thrust chamber. (See figure 10-7 for location and identification of insulators.)

k. Install special rubber band around thrust chamber and temporarily secure previously dry-fitted portion(s) of insulator(s) or entire insulators.

l. Prepare adhesive (paragraph 10-10).

WARNING

The following procedure specifies adhesive RTV-560, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

m. Using a sealant gun or spatula, apply catalyzed adhesive to inside surface of insulator(s). When using bulk material, distribute adhesive with paintbrush having approximately one-inch bristles.

n. Do not remove protective film from exterior surface of insulator(s) at this time.

o. Immediately install adhesive-backed insulator(s) in original dry-fitted position under special rubber band. Apply hand pressure to initiate adhesion to thrust chamber.

p. Using same dash-numbered pressure plate as insulator(s) being installed, position plate under special rubber band and center over joint between insulators.

NOTE

Insulator(s) must be positioned correctly and pressure plate must bear against hat band, tube support angle, hot-gas duct support, or fuel inlet duct, depending on which insulators are being repaired or installed.

q. Install pressure plates around entire circumference of thrust chamber, even if only one piece of insulator or portion of insulator is being installed.

r. Install 3 straps 209744 through metal loops of pressure plates, as soon as last plate has been installed.

s. Install a buckle AVB-4 on each strap and pull strap handtight.

t. Remove special rubber band from thrust chamber.

u. Install tensioner AVT-11C and tighten strap approximately 2-1/2 inches from one side only.

v. After insulation is installed, environment must remain at 72° to 100° F for a minimum of 8 hours for initial curing cycle. Leave pressure plates and straps in place a minimum of 24 hours to allow curing of adhesive.

w. Relieve clamping action of buckle AVB-4 by bending with pliers. Remove all pressure plates and straps and return them to Rocketdyne Representative.

x. Remove protective film from surface of each insulator.

WARNING

Toluene is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

Cloth must not be soaked with toluene. Excess toluene destroys insulation and adhesive.

y. Using clean cloth dampened with toluene, clean adhesive from insulators.

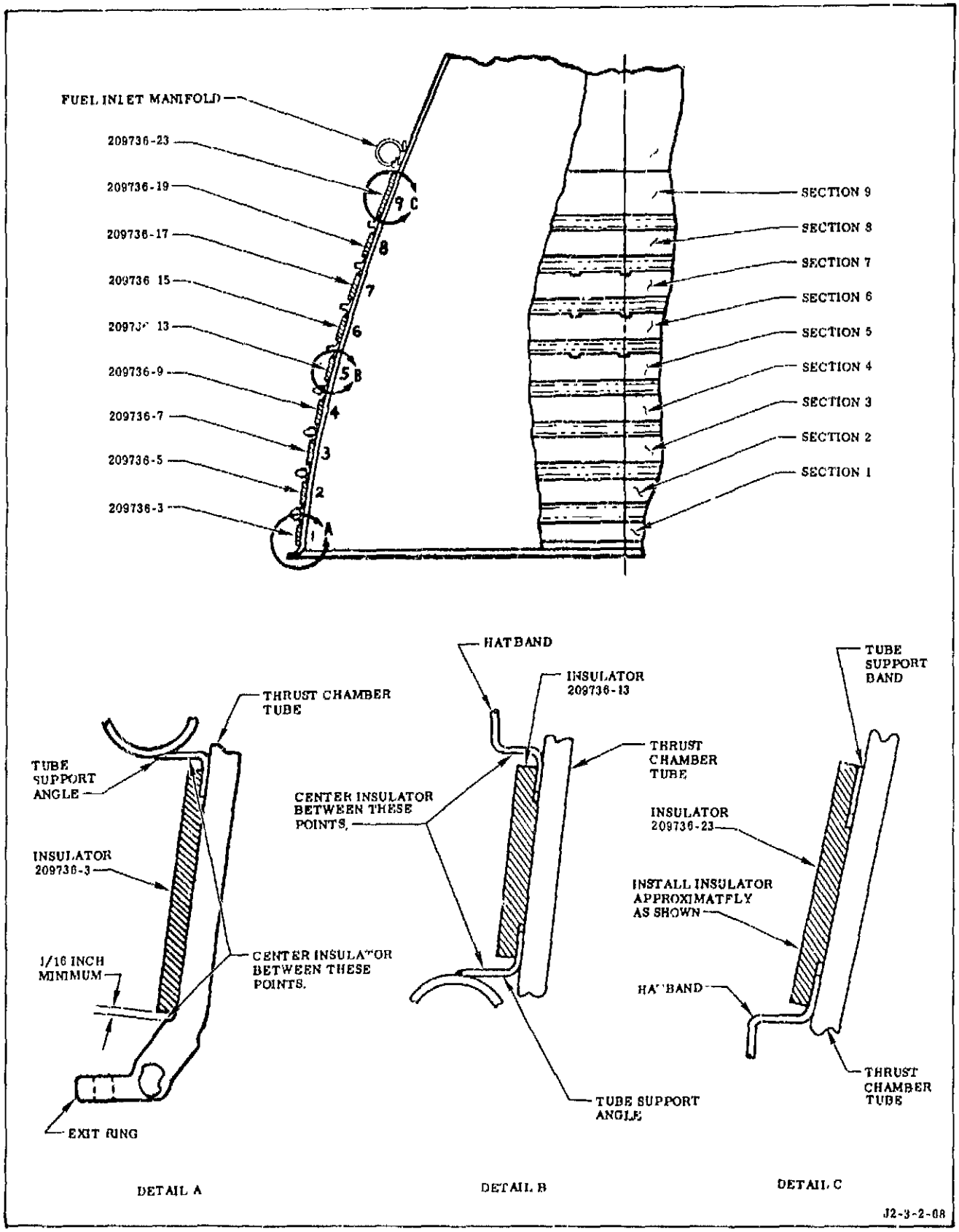


Figure 10-7. Thrust Chamber Tube Insulators

SECTION XI

INTEGRAL HYDROGEN-HELIUM START TANK

11-1. SCOPE. This section contains start tank cover, potting, and insulation repair information only. Post-maintenance testing is not included since testing is not required to validate repairs covered by this section.

11-2. REPAIRING DAMAGED FIBERGLASS COVER.

11-3. Figure 11-1 lists type and disposition for typical start tank fiberglass cover damage. A Rocketdyne Representative will provide disposition for damage outside the scope of figure 11-1.

11-4. MINOR COVER REPAIR.

a. Obtain the following equipment and materials, or their equivalents:

(1) Abrasive cloth, No. 160 grit (Federal Specification P-C-451).

(2) Trichloroethylene (MIL-T-27602).

(3) CAB-O-SIL Filler (Cabot Corp).

(4) Clean cloths.

(5) Epoxy hardener ERL-2807 (Union Carbide Corp).

(6) Epoxy resin ERL-2795 (Union Carbide Corp).

(7) No. 181 Volan fiberglass cloth (Hess, Goldsmith, and Co).

(8) Soft-bristle paintbrush.

(9) Spatula.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Make sure insulation is not wet. If insulation is wet, refer to paragraph 11-11.

d. Scrape or abrade all paint from a 2 inch area around surface to be repaired.

e. Using No. 160 grit abrasive cloth, roughen area for bonding.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

f. Clean area with trichloroethylene (MIL-T-27602).

WARNING

The following procedure specifies epoxy hardener ERL2807, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

g. Prepare filler by adding one part epoxy hardener to 5 parts epoxy resin (Union Carbide Corp), by weight or volume. Mix thoroughly while adding CAB-O-SIL filler (Cabot Corp). Add filler until mixture is thick enough to stay in place on a vertical surface.

h. Apply filler to crack, indentation, or hole in cover and fair to match contour of tank.

i. Allow filler to cure until hard. Length of time for filler to cure is dependant upon temperature, which must be 55° F or above in the area of repair for the filler/resin to cure satisfactorily. Heat may be applied to raise the ambient temperature in the area of repair to speed curing time. The approximate curing times are as follows:

(1) At 55° F, 48 hours.

(2) At 70° F, 16 hours.

CAUTION

Damage can result if heat exceeds 140° F at tank seals and components.

(3) At 180° F, 4 hours. Do not allow tank seals or components to heat to a temperature above 140° F.

j. After filler hardens, repeat steps e and f to prepare fiberglass cover surface for laminating resin.

k. Cut a piece of fiberglass cloth large enough to overlap all sides of crack, hole, or indentation by one to 1-1/2 inches.

l. Prepare a laminating resin by thoroughly mixing one part epoxy hardener with 5 parts of epoxy resin by weight or volume. (Life of mixture is approximately 15 minutes.)

m. Brush laminating resin on cleaned surface of cover; then position and press fiberglass cloth into resin.

n. Thoroughly impregnate cloth by brushing with more resin mixture; then work out trapped air bubbles with end of brush or spatula.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

o. Using a clean cloth dampened with trichloroethylene (MIL-T-27602), remove excess uncured resin from adjacent areas.

p. Allow resin to cure. (Refer to step l for approximate curing time.)

q. Paint (paragraph 11-8) repaired area.

11-5. MAJOR COVER REPAIR (DAMAGED AREA 36 SQUARE INCHES OR LESS).

a. Obtain the following equipment and materials, or their equivalents:

(1) Abrasive cloth, No. 160 grit (Federal Specification P-C-451).

(2) Trichloroethylene (MIL-T-27602).

(3) Radiac saw and slow-speed drill motor (500 rpm maximum), or hacksaw blade.

(4) Adiprene L-100 elastomer and MOCA catalyst (12-1/2 parts catalyst/100 parts elastomer) (Du Pont), or Narmco 7343 elastomer and Narmco 7139 Catalyst (12-1/2 parts catalyst/100 parts elastomer) (Narmco Industries), or Uralane 5712, Parts A and B (50 parts B/100 parts A) (Furane Plastics, Inc).

(5) Methyl-ethyl-ketone (Federal Specification TT-M-261).

(6) Malachite Green Dye (Allied Chemical Corp).

(7) Soft-bristle paintbrush.

(8) Vinyl or polyethylene film.

(9) No. 181 Volan fiberglass cloth (Hess, Goldsmith, and Co).

(10) Epoxy hardener ERL-2807 (Union Carbide Corp).

(11) Epoxy resin ERL-2795 (Union Carbide Corp).

(12) Clean cloths.

(13) Cleaning compound (MIL-C-81302) or trichloroethane (MIL-T-81553). (These materials are alternates for trichloroethylene (item 2) for removing excess resin.)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Using radiac saw or hacksaw blade, and being careful not to contact tank, remove damaged section of cover. (Blade must not penetrate cover more than 0.75 inch.)

d. Trim frayed edges of cover.

e. Cut three patches from fiberglass cloth. Cut first patch so that when it is centered over cutout area it will extend equally around the cutout area 1-1/2 to 3 inches. Cut second patch

1/4 to 1/2 inch larger (in all dimensions) than first patch and cut third patch 1/4 to 1/2 inch larger (in all dimensions) than second patch.

f. Scrape or abrade all paint from area around surface to be repaired to same size (+1/4, -0 inch) of largest patch; then, using No. 160 grit abrasive cloth, roughen area for bonding.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

g. Clean area with trichloroethylene (MIL-T-27602).

h. On tanks 303439 and 307571, remove and replace any wet insulation. (Refer to paragraph 11-11.)

WARNING

The following procedure specifies potting compound Uralane 5712, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

i. On tank 307579, do the following:

(1) Prepare a polyurethane coating by mixing 100 parts of Adiprene L-100 elastomer with 12-1/2 parts of MOCA catalyst, or 100 parts of Narmco 7343 elastomer with 12-1/2 parts of Narmco 7139 catalyst, or 100 parts A with 50 parts B or Uralane 5712.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

(2) Dissolve 175-200 grams of catalyzed elastomer, prepared in substep 1, in 50-60 milliliters of methyl-ethyl-ketone (TT-M-261) and 1/2 gram of Malachite Green Dye.

(3) Using soft brush, apply a liberal coating of material prepared in substep 2 to damaged areas resulting from removal of damaged cover section, ie, saw cuts, nicks, tears, etc.

CAUTION

Heat above 140° F will damage tank seals and components.

(4) Allow coating to cure 24 hours at ambient temperature, or cure by applying heat with a heat gun at 200° F for 30 minutes or a minimum of 125° F for a minimum of 90 minutes. Do not allow tank seals or components to heat above 140° F.

j. Place vinyl or polyethylene film over exposed insulation, stretch to remove wrinkles and tuck under edge of fiberglass cover. (Vinyl or polyethylene film prevents laminating resin from impregnating insulation.)

WARNING

The following procedure specifies epoxy hardener ERL2807, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

k. Prepare a laminating resin by thoroughly mixing one part epoxy hardener with 5 parts of epoxy resin by weight or volume. (Life of mixture is approximately 15 minutes.)

l. Brush resin on cleaned surface of cover around cutout and onto film covering insulation. Center smallest patch over cutout and press patch into resin. Thoroughly impregnate patch by brushing with more resin, and work out air bubbles with end of brush or spatula. Apply additional patches (largest patch last) in same manner as first patch. Do not exceed 5 minutes between application of patches.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

m. Using clean cloth dampened with trichloroethylene (MIL-T-27602), clean excess uncured resin from adjacent area.

n. Allow resin to cure. Length of time for resin to cure is dependant upon temperature, which must be 55° F or above in the area of repair for the resin to cure satisfactorily. Heat may be applied to raise the ambient temperature in the area of repair to speed curing time. The approximate curing times are as follows:

(1) At 55° F, 48 hours.

(2) At 70° F, 16 hours.

CAUTION

Damage can result if heat exceeds 140° F at tank seals and components.

(3) At 180° F, 4 hours. Do not allow tank seals or components to heat to a temperature above 140° F.

o. Paint (paragraph 11-8) repaired area.

11-6. MAJOR COVER REPAIR (DAMAGED AREA GREATER THAN 36 SQUARE INCHES). This task consists of cutting, removing, and replacing sections of the cover with an identical, undamaged section cut from a pre-cast cover. Damaged areas up to and including 600 square inches of cover surface in either or both hemispheres may be replaced, if the portion or portions removed do not include any part of the attach joint of the two hemispheres.

a. Obtain the following equipment and materials, or their equivalents:

(1) Abrasive cloth, No. 160 grit (Federal Specification P-C-451).

(2) Abrasive cloth, No. 120 grit (Federal Specification P-C-451).

(3) Trichloroethylene (MIL-T-27602).

(4) Radiac saw and slow-speed drill motor (500 rpm maximum), or hacksaw blade.

(5) No. 181 Volan fiberglass cloth (Hess, Goldsmith, and Co).

(6) Epoxy hardener ERL-2807 (Union Carbide Corp).

(7) Epoxy resin ERL-2795 (Union Carbide Corp).

(8) Soft-bristle paintbrush.

(9) Spatula.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Using a felt pen or equivalent, draw a line around portion of cover to be replaced.

d. Cut 3 patches from fiberglass cloth. Cut first patch so that when it is centered over new section it will extend equally around the cutout area 1-1/2 to 3 inches. Cut second patch 1/4 to 1/2 inch (in all directions) larger than first patch and cut third patch 1/4 to 1/2 inch (in all dimensions) larger than second patch.

e. Scrape or abrade all paint from area around fiberglass cover surface to be replaced to same size (+1/4, -0 inch) of largest patch; then using abrasive cloth, roughen area for bonding.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

f. Clean area with trichloroethylene (MIL-T-27602).

g. Using radiac saw or hacksaw blade, and being careful not to contact tank, remove damaged section of cover.

h. Using removed portion of tank cover as a template, place template onto new cover section and aline common girth axes of old and new covers. Outline template on new cover section.

i. Scrape or abrade paint from outer surface of new cover section within outlined area.

j. Using abrasive cloth, roughen area for bonding.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

k. Clean area with trichloroethylene (MIL-T-27602).

l. Using radiac saw or hacksaw blade, carefully cut out new section of cover material to fit cutout on installed tank cover, with a joint gap of 1/8 inch maximum.

m. On tanks 303439 and 307571, remove and replace any wet insulation. (Refer to paragraph 11-11.)

n. Place new section of cover on tank.

WARNING

The following procedure specifies epoxy hardener ERL2807, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

o. Prepare approximately 1/4 cup of a laminating resin by thoroughly mixing one part epoxy hardener with 5 parts of epoxy resin by weight or volume. (Life of mixture is approximately 15 minutes.)

p. Brush resin on cleaned surface of cover. Center smallest patch over new section and press patch into resin. Thoroughly impregnate patch by brushing with more resin, and work out entrapped air bubbles with end of brush or spatula. Apply additional patches (largest piece last) in same manner as first patch. Do not exceed 5 minutes between application of patches.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

q. Using clean cloth dampened with trichloroethylene (MIL-T-27602), clean excess uncured resin from adjacent areas.

r. Allow resin to cure. Length of time for resin to cure is dependant upon temperature, which must be 55° F or above in the area of repair for the resin to cure satisfactorily. Heat may be applied to raise the ambient temperature in the area of repair to speed curing time. The approximate curing times are as follows:

(1) At 55° F, 48 hours.

(2) At 70° F, 16 hours.

CAUTION

Damage can result if heat exceeds 140° F at tank seals and components.

(3) At 180° F, 4 hours. Do not allow tank seals or components to heat to a temperature above 140° F.

s. After repaired area has cured, abrade rough edges of cloth with abrasive cloth. Abrade entire area to remove resin gloss and promote paint adhesion.

t. After abrading, repeat step k to remove abrasive dust.

u. Paint (paragraph 11-8) repaired area.

11-7. REPAIRING BUCKLED OR DISHED AREAS.

a. Obtain the following equipment and materials, or their equivalents:

(1) Equipment to drill 0.18 or 1.0 inch hole in tank cover.

(2) Abrasive cloth, No. 160 grit (Federal Specification P-C-451).

(3) Trichloroethylene (MIL-T-27602).

(4) No. 181 Volan fiberglass cloth (Hess, Goldsmith, and Co).

(5) Vinyl or polyethylene film. (Required only if 1.6 inch hole is drilled in cover.)

(6) Epoxy hardener ERL-2807 (Union Carbide Corp).

(7) Epoxy resin ERL-2795 (Union Carbide Corp).

(8) Soft-bristle paintbrush.

(9) Spatula. (Optional. Used to work out air bubbles; soft bristle brush may be substituted.)

(10) Clean cloths.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Drill a 0.18 inch diameter hole in bottom of buckle or dished area, insert a hooked instrument in hole, and pull out until buckle or dished area conforms to original contour, or drill one-inch diameter hole adjacent to buckle or dished area and lift out area with fingers or suitable instrument. Take care not to damage insulation or tank surface.

d. Scrape or abrade all paint from a 2 inch area around buckled or dished area.

e. Using abrasive cloth, roughen area for bonding.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

f. Clean area with trichloroethylene (MIL-T-27602).

g. Cut a piece of fiberglass cloth large enough to overlap all sides of buckled or dished area by one to 1-1/2 inches.

h. If one-inch diameter hole was drilled in cover, place a piece of vinyl or polyethylene film over any exposed insulation, stretch to remove wrinkles, and tuck under edge of fiberglass cover. (Vinyl or polyethylene film prevents laminating resin from impregnating insulation.)

WARNING

The following procedure specifies epoxy hardener ERL2807, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

i. Prepare a laminating resin by thoroughly mixing one part epoxy hardener with 5 parts of epoxy resin by weight or volume. (Life of mixture is approximately 15 minutes.)

j. Brush resin on cleaned surface of cover, center patch over repair area, and press patch into resin. Thoroughly impregnate patch by brushing with more resin, and work out trapped air bubbles with end of brush or spatula.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

k. Using clean cloth dampened with trichloroethylene (MIL-T-27602), clean excess uncured resin from adjacent areas.

l. Allow resin to cure. Length of time for resin to cure is dependant upon temperature, which must be 55° F or above in the area of repair for the resin to cure satisfactorily. Heat may be applied to raise the ambient temperature in the area of repair to speed curing time. The approximate curing times are as follows:

(1) At 55° F, 48 hours.

(2) At 70° F, 16 hours

CAUTION

Damage can result if heat exceeds 140° F at tank seals and components.

(3) At 180° F, 4 hours. Do not allow tank seals or components to heat to a temperature above 140° F.

m. Paint (paragraph 11-8) repaired area.

11-8. REPAIRING PAINTED SURFACE.

a. Obtain the following equipment and materials, or their equivalents:

(1) Stiff-bristle brush.

(2) Smooth wooden or plastic dull-edge scraper.

(3) Sandpaper, No. 240 or 400 grit.

(4) Emery paper, No. 320 grit.

(5) Clean, lint-free cloths.

(6) Stoddard solvent (Federal Specification P-D-680, Type I).

(7) Masking tape and paper, plugs, etc, as necessary to protect adjacent surfaces.

(8) Passive temperature-control coating RR0125-001, Type I (Rocketdyne).

(9) Soft-bristle paintbrush. (Required only if coating is to be brushed on.)

(10) Xylene (Federal Specification TT-X-916).

(11) No. 2 Zahn viscosimeter.

(12) No. 50 aerosol power unit spray gun (W. P. Fuller Co).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Using stiff-bristle brush and smooth wooden or plastic dull-edged tool, remove all loose paint in area to be repaired.

d. Using sandpaper, fair all rough edges of paint around area to be repaired. If exposed surface of start tank insulation cover is glossy smooth, remove gloss by sanding lightly with emery paper.

e. If new lamination has been applied to cover, sand lightly with emery paper.

f. Clean surface to be painted by wiping with a clean, lint-free cloth dampened with solvent.

g. Cover all surfaces that are not to be coated, including adjacent components, with masking paper, tape, plugs or other suitable materials.

h. For brush-on applications, apply coating as follows:

(1) Use a clean, soft-bristle paintbrush.

(2) Apply 3 coats of undiluted passive-temperature-control coating (RR0125-001, Type I), allowing 15-30 minutes drying time between each coat.

i. For spray-on applications, apply coating as follows:

WARNING

Xylene is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

(1) Thoroughly mix 3 parts by volume of passive-temperature-control coating with one part by volume of xylene.

(2) Using No. 2 Zahn viscosimeter, check viscosity of mixture. Viscosity must be 16-20 seconds. If viscosity exceeds 20 seconds, add more xylene. If viscosity is less than 16 seconds, add more coating.

(3) Apply one full wet coat over entire surface to be repaired, using aerosol power unit spray gun and maintaining a traversing rate that gives a wet coat without feathering, sagging, or running.

(4) Allow coating to air dry for 15 minutes.

(5) Apply a cross-coat until complete hiding of exposed surface is attained.

(6) Allow painted surfaces to air dry for a minimum of 48 hours.

11-9. REPAIRING DAMAGED POTTING.

11-10. If the bond is broken between the potting and fiberglass cover, or the potting and start tank, or if the potting is broken into small, loose pieces, repair as follows:

a. Obtain the following equipment and materials or their equivalents:

(1) Spatula to remove loose pieces of potting.

(2) Trichloroethylene (MIL-T-27602), cleaning compound (MIL-C-81302), or trichloroethane (MIL-T-81533).

(3) White sealant RTV-102 (General Electric).

(4) Flexible metal or plastic spatula, or pressure gun, Model 250 (Products Research and Chemical, Semco), retainer No. 606 (Products Research and Chemical, Semco), sealant cartridge No. SF-250-C6-RTV102 (Products Research and Chemical, Semco), and nozzle No. 8690 (Products Research and Chemical, Semco).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Inspect for and replace any wet insulation. (Refer to paragraph 11-11.)

d. Remove broken, loose pieces of potting compound with spatula. Leave potting if damage consists of separation of potting from either fiberglass cover or metal connections.

WARNING

The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

e. Clean bonding surfaces of tank and/or fiberglass cover in repair area by wiping with a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602), cleaning compound (MIL-C-81302), or trichloroethane (MIL-T-81533).

WARNING

The following procedure specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

f. Allow bonding surfaces to air-dry; then apply an even, continuous coat of white sealant.

g. Using flexible metal or plastic spatula, or pressure gun, retainer, sealant cartridge, and nozzle, force sealant into crack or depression.

h. Allow sealant to cure. Sealant will cure in 24 hours at 72° F. Curing time will be longer at temperatures below 72° F. (There are no requirements for temperature or humidity control.)

11-11. REPAIRING DAMAGED FIBERGLASS INSULATION.

11-12. Insulation used on tank 307579 is coated on all exposed surface areas with a durable moisture-proof elastomer coating. As a result of the elastomer application, no wet insulation problems are expected on tank 307579. If, in the process of performing cover repairs to tank 307579, the elastomer coating is damaged, repair damaged areas as outlined in paragraph 11-5. On tanks 303439 and 307571, the only way moisture can enter the insulation is through a damaged cover or damaged potting. Wet insulation exceeding 250 square inches must be

replaced, or the start tank replaced. An estimate of how large an area of insulation is wet can be made by cutting one-inch inspection holes (10 maximum) in suspected areas of the fiberglass cover. If enough wet insulation cannot be removed using procedures in paragraph 11-13, the start tank must be replaced, or the outboard section of the cover removed and the wet insulation replaced (paragraph 11-14).

11-13. MINOR INSULATION REPAIR. Minor insulation repair consists of removing wet insulation by cutting a maximum of 4 holes, 36 square inches, in covers 303441 or 307577 and a maximum of 2 holes, 36 square inches, in covers 303440 or 307576. Maintain a minimum of 4 inches between openings.

a. Obtain the following equipment and materials, or their equivalents:

(1) Radiac saw and slow-speed drill motor (500 rpm maximum), or hacksaw blade.

(2) No. 181 Volan fiberglass cloth (Hess, Goldsmith, and Co, Inc.)

(3) Abrasive cloth, No. 160 grit (Federal Specification P-C-451).

(4) Trichloroethylene (MIL-T-27602).

(5) Micro-Fibre felt insulation, Type 475 (Johns-Manville Products).

(6) Clean cloth.

(7) Vinyl or polyethylene film.

(8) Epoxy hardener ERL-2807 (Union Carbide Corp).

(9) Epoxy resin ERL-2795 (Union Carbide Corp).

(10) Soft-bristle paintbrush.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Using radiac saw or hacksaw blade, and being careful not to contact tank, remove damaged section of cover. (Blade must not penetrate cover more than 0.25 inch.)

d. Trim frayed edges of cover.

e. Remove any wet insulation.

f. Cut 3 patches from fiberglass cloth. Cut first patch so that when it is centered over cutout area, it will extend equally around the cutout area 1-1/2 to 3 inches. Cut second patch 1/4 to 1/2 inch larger (in all dimensions) than first patch and cut third patch 1/4 to 1/2 inch larger (in all dimensions) than second patch.

g. Scrape or abrade all paint from area around surface to be repaired to same size (+1/4, -0 inch); then, using abrasive cloth, roughen area for bonding.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

h. Clean area with trichloroethylene (MIL-T-27602).

i. Cut and position a 1-1/4-inch thick layer, consisting of any combination of material thickness of Micro-Fibres felt insulation into cut-out areas.

j. Trim insulation to fit cutout area, contour to fit tank and cover interior, and place in cut-out area. If multiple layers are used, relationship of different layers due to thickness is optional.

k. Place a piece of vinyl or polyethylene film over exposed insulation, stretch to remove wrinkles, and tuck under edge of fiberglass cover. (Vinyl or polyethylene film prevents laminating resin from impregnating insulation.)

WARNING

The following procedure specifies epoxy hardener ERL2807, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

l. Prepare a laminating resin by thoroughly mixing one part epoxy hardener with 5 parts of epoxy resin by weight or volume. (Life of mixture is approximately 15 minutes.)

m. Brush resin on cleaned surface of cover around cutout and onto film covering insulation. Center smallest patch over cutout and press patch into resin. Thoroughly impregnate patch by brushing with more resin, and work out trapped air bubbles with end of brush or spatula. Apply additional patches (largest patch last) in same manner as first patch. Do not exceed 5 minutes between application of patches.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

n. Using a clean cloth dampened with trichloroethylene (MIL-T-27602), clean excess uncured resin from adjacent areas.

o. Allow resin to cure. Length of time for resin to cure is dependant upon temperature, which must be 55° F or above in the area of repair for the resin to cure satisfactorily. Heat may be applied to raise the ambient temperature in the area of repair to speed curing time. The approximate curing times are as follows:

(1) At 55° F, 48 hours.

(2) At 70° F, 16 hours.

CAUTION

Damage can result if heat exceeds 140° F at tank seals and components.

(3) At 180° F, 4 hours. Do not allow tank seals or components to heat to a temperature above 140° F.

p. Paint (paragraph 11-8) repaired area.

11-14. MAJOR INSULATION REPAIR. Major insulation repair consists of removing the outboard section of the fiberglass cover and replacing wet insulation.

a. Obtain the following equipment and materials, or their equavalents:

(1) Hacksaw blade.

(2) Micro-Fiber felt insulation, Type 475 (Johns-Manville Products).

(3) Abrasive cloth No. 120 grit (Federal Specification P-C-451).

(4) Abrasive cloth No. 160 grit (Federal Specification P-C-451).

(5) No. 181 Volan fiberglass cloth (Hess, Goldsmith, and Co).

(6) Epoxy hardener ERL-2807 (Union Carbide Corp).

(7) Epoxy resin ERL-2795 (Union Carbide Corp).

(8) Trichloroethylene (MIL-T-27602).

(9) Soft-bristle paintbrush.

(10) Clean cloths.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove fuel turbine exhaust duct. (Refer to R-3825-3 Volume I.)

d. Locate a point on cover-to-cover attach joint of start tank cover, 90 degrees from center of helium port. From this point draw a line completely around tank cover, 90 degrees to cover-to-cover attach joint. Mark this line as plane A.

e. From cover-to-cover attach joint, measure along plane A on cover 303441 or 307577, 22.0 ±0.25 inches. Mark this point as point B.

f. On cover 303441 or 307577, locate 2 points on plate A that are 6.50 ±0.25 inches from cover-to-cover attach joint. Mark both of these points as point C.

g. From point B draw a line on cover 303441 or 307577 to helium port.

h. From point B measure 9.0 ±0.25 inches along line drawn in step g. Mark this point as point D.

i. Draw 2 lines on cover 303441 or 307577 to connect both points marked C to point D. These 2 lines, which connect both points marked C plus remainder of plane A (through cover 303440 or 307576), comprise the cutting outline for removing cover.

j. Scrape or abrade all paint from a 2 inch wide surface each side of line scribing portion of tank cover to be removed.

CAUTION

Extreme care must be taken to prevent damage to the start tank surface during cutting.

k. Using hacksaw blade, cut fiberglass cover along outline (step i). (Blade must not penetrate cover more than 0.75 inch.)

CAUTION

Extreme care must be taken when removing wet insulation from the installed half of cover, to prevent damage to the potting compound that seals cover to each of the tank ports.

l. Carefully remove fiberglass cover and all wet insulation.

m. Cut a 1-1/4-inch thick layer of insulation, consisting of any combination of material thicknesses, and place into removed cover, leaving a 2-1/2 ±1/4 inch margin around complete periphery of cover without insulation.

CAUTION

Extreme care must be taken when installing new insulation to prevent damage to the potting compound that seals cover to each of the tank ports.

n. Cut a 1-1/4-inch thick layer of insulation, consisting of any combination of material thicknesses, and fill cavity between installed cover and tank leaving a 2-1/2 ±1/4-inch margin around complete periphery of cover without insulation.

o. Cut strips 5-1/2 ±1/4 inch-wide of 1/2 inch and 3/4 inch thick insulation. Position under installed cover, leaving half of strip exposed.

p. Position removed section of cover on tank, in original position to installed section of cover. Ensure a clearance of at least one inch between tank surface and fuel turbine exhaust duct flat spot on cover 303441 or 307577. This measurement can be made by drilling a 1/16 inch hole in center of flat spot on cover and gently inserting a needle (by hand) until it bottoms out on tank surface.

q. Scrape or abrade all paint from a 2 inch area around 1/16 inch hole drilled in cover 303441 or 307577, and, using abrasive cloth, roughen area for bonding.

r. Cut out a peice of fiberglass cloth to fit area prepared in step q.

s. Cut 3 patches from fiberglass cloth to same shape as cut on tank cover. Cut first patch so that when it is centered on cut, it will extend equally each side of cut, 1-1/2 to 3 inches. Cut second patch 1/4 to 1/2 inch wider than first patch and cut third patch 1/4 to 1/2 inch wider than second patch.

WARNING

The following procedure specifies epoxy hardener ERI 2807, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

t. Prepare approximately 1/4 cup of laminating resin by thoroughly mixing one part epoxy hardener with 5 parts of epoxy resin by weight or volume. (Life of mixture is approximately 15 minutes.)

u. Brush resin on cleaned surface of cover, center smallest patch over cut and press patch into resin. Thoroughly impregnate patch by brushing with more resin, and work out entrapped air bubbles with end of brush or spatula. Apply additional patches (largest patch last) in same manner as first patch. Do not exceed 5 minutes between application of patches.

v. Make sure clearance in step p has been maintained; then repair the 1/16-inch hole as follows:

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

(1) Clean area with trichloroethylene (MIL-T-27602).

(2) Brush laminating resin on prepared surface around hole, center patch over area, and press cloth into resin. Thoroughly impregnate patch by brushing with more resin, and work out trapped air bubbles with end of brush or spatula.

w. Using clean cloth dampened with trichloroehtylene (MIL-T-27602), clean excess uncured resin off adjacent areas before curing.

x. Allow resin to cure. Length of time for resin to cure is dependant upon temperature, which must be 55° F or above in the area of repair for the resin to cure satisfactorily. Heat may be applied to raise the ambient temperature in the area of repair to speed curing time. The approximate curing times are as follows:

(1) At 55° F, 48 hours.

(2) At 70° F, 16 hours.

CAUTION

Damage can result if heat exceeds 140° F at tank seals and components.

(3) At 180° F, 4 hours. Do not allow tank seals or components to heat above 140° F.

y. After repaired area has cured, abrade rough edges with abrasive cloth. Abrade entire area to remove resin gloss and promote paint adhesion.

z. Wipe off abrasive duct.

aa. Paint (paragraph 11-8) repaired area.

ab. Install fuel turbine exhaust duct. (Refer to R-3825-3, Volume I.)

Damage	Limit	Disposition
Cracks.	Any cracks.	Refer to minor cover repair, paragraph 11-4.
Indentations.	3/8 inch wide or less by 1/4 inch deep or less (unlimited length).	Refer to minor cover repair, paragraph 11-4.
	Greater than 3/8 inch wide and/or 1/4 inch deep, but less than a total area of 36 square inches.	Refer to major cover repair, paragraph 11-5. If tank surface is damaged, replace tank.
	Area greater than 36 square inches.	Install pre-cast section (paragraph 11-6). If pre-cast section cannot be obtained, replace tank.
Holes, burns, cuts, or shattered areas.	For covers 303441 or 307577, a maximum of 4 holes or damaged areas, 36 square inches or less, provided a minimum of 4 inches can be maintained between openings.	Four holes or damaged areas may be repaired at any one time. Repair (paragraph 11-5). Additional holes or damaged areas can be repaired after initial repair has cured.
	For covers 303440 or 307576, a maximum of 2 holes or damaged areas, 36 square inches or less, provided a minimum of 4 inches can be maintained between openings.	Two holes or damaged areas may be repaired at any one time. Repair as outlined in paragraph 11-5. Additional holes or damaged areas can be repaired after initial repair has cured.
	Greater than 36 square inches and less than 600 square inches.	Install pre-cast section (paragraph 11-6). If pre-cast section cannot be obtained, replace tank.
Buckled or dished areas.		Repair (paragraph 11-7).
Damaged paint.	Painted surfaces that are chipped, cracked, scratched, blistered, peeling, or damaged in any way.	Repair (paragraph 11-8).
Oily, greasy, or dirty		Clean by wiping with a clean soft cloth dampened with a solution of 3.5 percent Turco cleaning compound 4215 (Turco Products) and warm water. Oil and grease not removable with this solution can be cleaned by wiping with a clean soft cloth dampened with Stoddard solvent (Federal Specification P-D-680, Type I).

Figure 11-1. Start Tank Fiberglass Cover Damage Limits

SECTION XII

MAINSTAGE OK PRESSURE SWITCH

WARNING

COMPONENTS ADAPTER SET 9016796 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

12-1. SCOPE. This section contains mainstage OK pressure switch functional and preinstallation test requirements. Repair information is not included, since mainstage OK pressure switches are not field repairable.

12-2. FUNCTIONAL TESTING MAINSTAGE OK PRESSURE SWITCH.

12-3. The functional test consists of testing switch actuation and deactuation, and insulation resistance.

12-4. TESTING MAINSTAGE OK PRESSURE SWITCH ACTUATION AND DEACTUATION. Testing switch actuation and deactuation consists of individually pressurizing and depressurizing the pressure and calibration ports, and verifying that switch operation is within acceptable limits.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Obtain the following test equipment and materials, or their equivalents, and see figure 12-1 for test requirements.

(1) Pneumatic test chamber 61312.

(2) Equipment and materials to assemble test setup (figure 12-2).

(3) Gaseous nitrogen source, pressurized to a minimum of 1,000 psig. Nitrogen must conform to the pressurizing and purging requirements for nitrogen in R-3825-3, Volume I.

12-5. TESTING MAINSTAGE OK PRESSURE SWITCH INSULATION RESISTANCE. The insulation resistance test consists of testing resistance between open switch contacts, and between the contacts and the case of the switch.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following test equipment and materials, or their equivalents, and see figure 12-3 for test requirements. Items 1 through 3 will have been obtained if the switch insulation test is being performed after a switch actuation and deactuation test.

(1) Pneumatic test chamber 61312.

(2) Equipment and materials for applying pneumatic pressure to either the pressure or calibration port. (See figure 12-2.)

(3) Gaseous nitrogen source, pressurized to a minimum of 550 psig. Nitrogen must conform to the pressurizing and purging requirements for nitrogen in R-3825-3, Volume I.

(4) Megohmmeter, Model 1020C (Freed Transformer Co).

12-6. PREINSTALLATION TESTING MAINSTAGE OK PRESSURE SWITCH.

12-7. The preinstallation test is the same as a functional test (paragraph 12-2).

Step	Operation	Result
	NOTE When performing this test, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I. • This test must be performed with the ambient, test fluid, and component temperatures at 70 ±15° F.	
1	Install mainstage OK pressure switch into test setup (see figure 12-2). Connect pressure port to source of pressurized nitrogen. Make sure calibration port is open to atmosphere.	
2	Connect mainstage OK pressure switch electrical connector to a visual monitoring system that will indicate switching of pin B to pin A or to pin C. Continuity from pin B to pin A indicates switch is depressurized. Continuity from pin B to pin C indicates switch is pressurized.	
	NOTE Unless otherwise noted in this test, the pressurization or depressurization rate of the mainstage OK pressure switch must not exceed 100 psig a second.	
3	Apply 425-450 psig to mainstage OK pressure switch pressure port.	Continuity is indicated between pins A and B.
4	Increase pressure to pressure port at a rate of 2-5 psig a second until switch continuity transfers from pins A and B to pins B and C. Note pressure at which switch transfers.	Switch must transfer at 500 ±20 psig.
5	Increase pressure to pressure port to 900 (+25, -0) psig.	
6	Decrease pressure to pressure port to a minimum of 500 psig.	
7	Decrease pressure to port at a rate of 2-5 psig a second until switch continuity transfers from pins B and C to pins A and B.	Switch must transfer at 45-105 psig below pressure noted in step 4.
8	Decrease pressure to pressure port to zero.	
9	Repeat steps 3 through 8 two times.	Results must be duplicated within ranges noted.
10	Connect calibration port to source of pressurized nitrogen. Make sure pressure port is open to atmosphere.	
11	Apply 425-450 psig to calibration port.	Continuity is indicated between pins A and B.
12	Increase pressure to calibration port at a rate of 2-5 psig a second until switch continuity transfers from pins A and B to pins B and C. Note pressure at which switch transfers.	Switch must transfer at 500 ±25 psig.

Figure 12-1. Testing Mainstage OK Pressure Switch Actuation and Deactuation (Sheet 1 of 2)

Step	Operation	Result
13	Increase pressure to calibration port to 900 (+25, -0) psig.	
14	Decrease pressure to calibration port to a minimum of 500 psig.	
15	Decrease pressure to calibration port at a rate of 2-5 psig a second until switch continuity transfers from pins B and C to pins A and B.	Switch must transfer at 20-105 psig below pressure noted in step 12.
16	Decrease pressure to calibration port to zero.	
17	Repeat steps 11 through 16 two times.	Results must be duplicated within ranges noted.
18	If insulation resistance test (paragraph 12-5) is not to be performed, secure test equipment and disassemble test setup. If insulation resistance test is to be performed, disconnect visual monitoring system from mainstage OK pressure switch electrical connector and delete step 19.	
19	Repackage mainstage OK pressure switch and attach condition tag.	

Figure 12-1. Testing Mainstage OK Pressure Switch Actuation and Deactuation (Sheet 2 of 2)

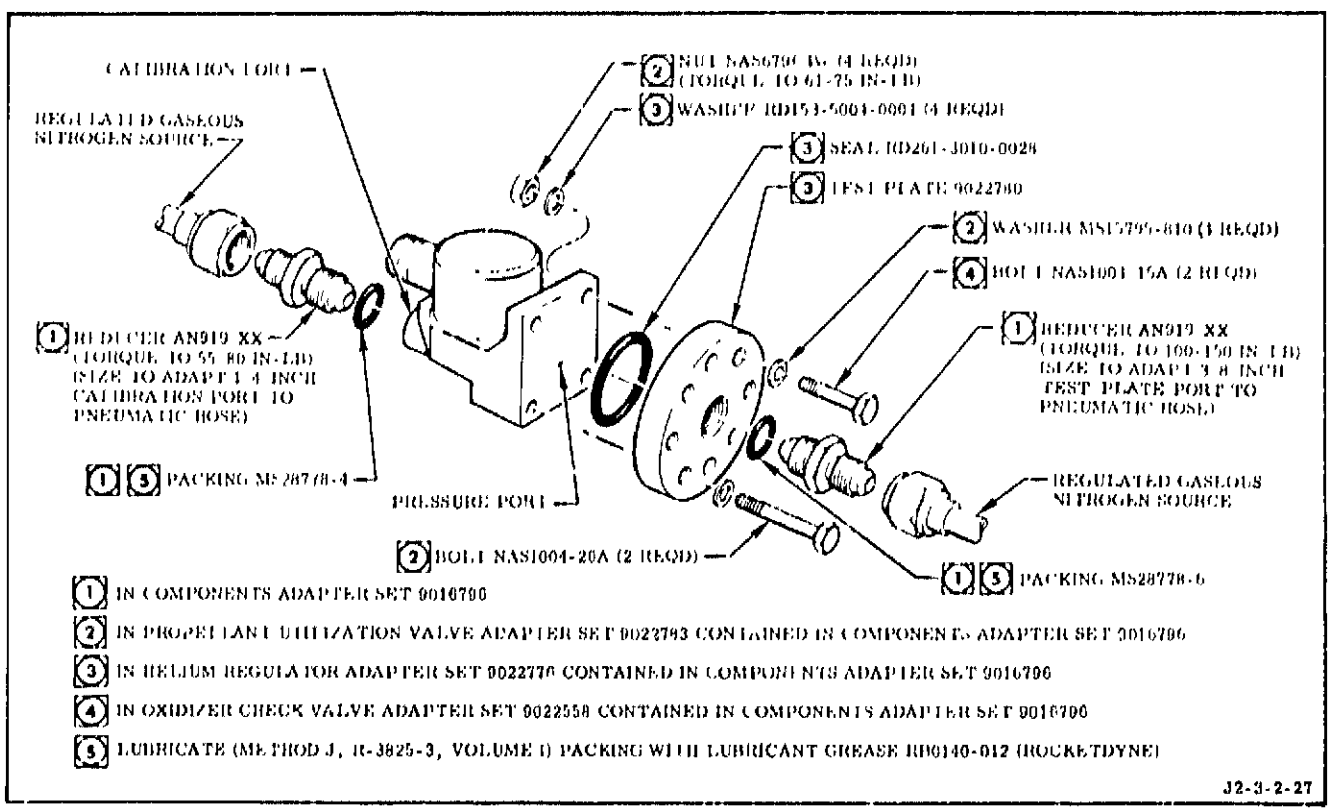


Figure 12-2. Mainstage OK Pressure Switch Test Setup

Step	Operation	Result
	NOTE When performing this test, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I. • This test must be performed with the ambient, test fluid, and component temperatures at 70 ±15° F. • If mainstage OK pressure switch is installed in test setup (see figure 12-2), delete step 1.	
1	Attach necessary fittings to mainstage OK pressure switch for applying pneumatic pressure to either the pressure or calibration port. (See figure 12-2.) Make sure unused port is open to atmosphere.	
2	Attach megohmmeter test leads to pins A and B of mainstage OK pressure switch electrical connector. Do not energize megohmmeter, since with switch depressurized, continuity exists between pins A and B.	
	NOTE Whenever this procedure requires pressurization or depressurization, the pressurization or depressurization rate must not exceed 100 psig a second.	
3	Apply 575 ±25 psig to mainstage OK pressure switch.	
4	Using megohmmeter, apply 500-600 vdc for 5-15 seconds between pins A and B and note resistance.	500 megohms minimum.
5	Deenergize megohmmeter and then decrease pressure to mainstage OK pressure switch to zero.	
6	Using megohmmeter, apply 500-600 vdc for 5-15 seconds between the following and note resistance:	
	a. Pin A to pin C	500 megohms minimum.
	b. Pin A to case	500 megohms minimum.
	c. Pin C to case	500 megohms minimum.
7	Secure test equipment and remove mainstage OK pressure switch from test setup.	
8	Repackage mainstage OK pressure switch and attach condition tag.	

Figure 12-3. Testing Mainstage OK Pressure Switch Insulation Resistance

12-8. MAINSTAGE OK PRESSURE SWITCH STRESS CORROSION INSPECTION.

12-9. Inspect areas identified in figure 12-4 of the mainstage OK pressure switch base for crack-like defects caused by stress corrosion as follows:

a. Visually inspect areas for crack-like defects. Use illumination and magnification up to 10X where necessary to obtain better definition or to clarify suspect areas.

b. If crack-like defects exceed 0.1 inch, coordinate disposition with Rocketdyne representative.

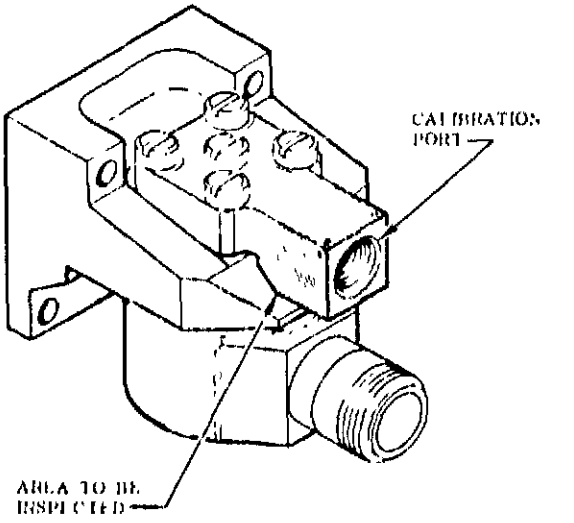


Figure 12-4. Mainstage OK Pressure Switch Stress Corrosion Inspection

SECTION XIII

OXIDIZER TURBOPUMP

WARNING

OXIDIZER TURBOPUMP MAINTENANCE SET 9020798-11 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

13-1. SCOPE. This section contains allowable field level disassembly and reassembly procedures for the oxidizer turbopump pump and turbine ends. Also included are inspection guides, to aid in evaluating the suitability of turbopump components for reuse, and post-maintenance test requirements.

13-2. DISASSEMBLING PUMP END.

13-3. Figure 13-1 illustrates components of the oxidizer turbopump pump end that may be removed for field level maintenance. Procedures for removing these components are in paragraphs 13-4 through 13-9.

13-4. REMOVING INDUCER SHROUD CARRIER AND PISTON RING. (See figure 13-1.) The inducer shroud carrier cannot be replaced without affecting engine calibration. Parts replacement is limited to attaching hardware (8, 9, 10), inlet carrier retainers (11), and piston ring (13).

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Remove oxidizer inlet duct. Refer to R-3825-3, Volume I.

c. Straighten tabs on locktabs (8, 10) and remove bolts (9), locktabs (8, 10), and inlet carrier retainers (11). Discard locktabs (8, 10).

d. Matchmark inducer shroud carrier (12) to volute (7). Do not impression stamp.

e. Temporarily reinstall 2 bolts (9), 180 degrees apart, in inducer shroud carrier (12) and using installed bolts (9) as handholds remove inducer shroud carrier (12).

f. Remove piston ring (13).

13-5. REMOVING INDUCER SHROUD. (See figure 13-1.) The inducer shroud cannot be replaced without affecting engine calibration. Parts replacement is limited to attaching hardware (18, 19).

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Remove oxidizer inlet duct. Refer to R-3825-3, Volume I.

c. Straighten tabs on locktabs (19) and remove bolts (18) and locktabs (19). Discard locktabs (19).

d. Matchmark inducer shroud restraining ring (20) to inducer shroud carrier (12). Do not impression stamp.

e. Remove inducer shroud restraining ring (20).

f. Matchmark inducer shroud (21) to inducer shroud carrier (12). Do not impression stamp.

g. Remove inducer shroud (21).

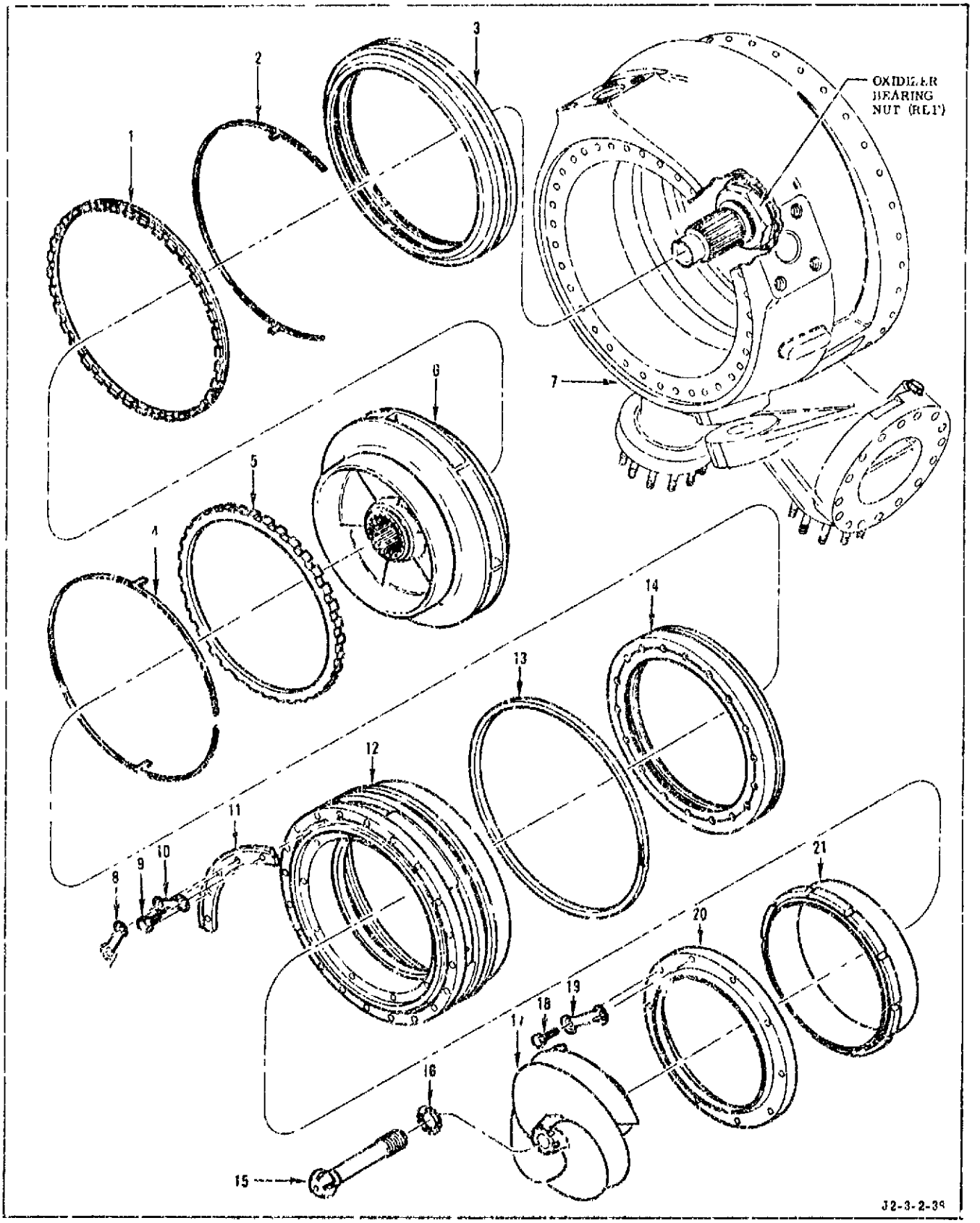


Figure 13-1. Pump End of Oxidizer Turbopump (Sheet 1 of 2)

Index No.	Nomenclature	Index No.	Nomenclature
1	Impeller outlet seal retaining nut	12	Inducer shroud carrier
2	Impeller outlet seal nut lockring	13	Piston ring
3	Impeller outlet seal assembly	14	Impeller inlet seal assembly
4	Impeller inlet seal nut lockring	15	Inducer bolt
5	Impeller inlet seal retaining nut	16	Inducer bolt lockwasher
6	Impeller	17	Inducer
7	Volute	18	Inducer shroud retaining bolts
8	Inlet carrier retaining bolt locktab	19	Inducer shroud retaining bolt locktab
9	Inlet carrier retaining bolts	20	Inducer shroud restraining ring
10	Inlet carrier retaining bolt locktab	21	Inducer shroud
11	Inlet carrier retainer		

Figure 13-1. Pump End of Oxidizer Turbopump (Sheet 2 of 2)

13-6. REMOVING IMPELLER INLET (OUTER) SEAL ASSEMBLY. (See figure 13-1.) The impeller inlet seal assembly cannot be replaced without affecting engine calibration. Parts replacement is limited to the impeller inlet seal retaining nut (5) and lockring (4).

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following kits:

(1) Oxidizer turbopump inner and outer impeller seal puller kit 9022281.

(2) Oxidizer turbopump carrier seal adapter kit 9022283.

(3) Oxidizer turbopump outer impeller seal retainer nut spanner wrench kit 9022285.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove inducer shroud carrier (paragraph 13-4).

d. Install inducer shroud carrier (12) with impeller inlet seal retaining nut (5) up, into adapter 9022300 (oxidizer turbopump carrier seal adapter kit 9022283) and secure with bolts and washers. (See figure 13-2.)

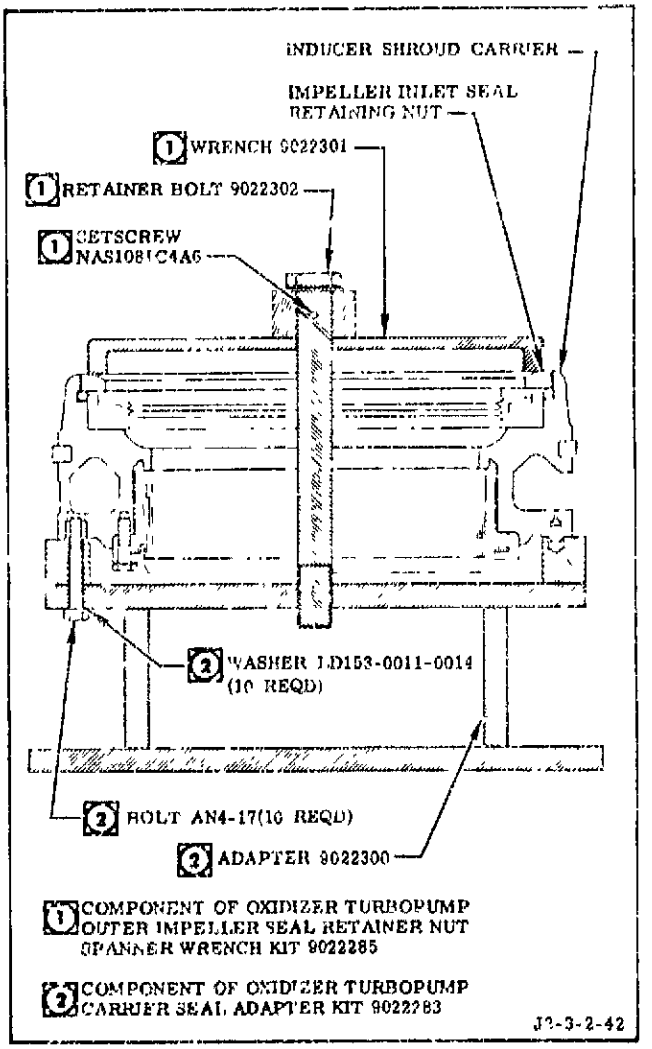


Figure 13-2. GSE Setup for Impeller Inlet Seal Retaining Nut

e. Straighten tabs on impeller inlet seal nut lockring (4).

f. Matchmark impeller inlet seal assembly (14) to inducer shroud carrier (12). Do not impression stamp.

g. Using retainer nut spanner wrench kit 9022285 remove impeller inlet seal retaining nut (5).

h. Remove and discard impeller inlet seal nut lockring (4).

i. Using impeller seal puller kit 9022281 (figure 13-3) remove impeller inlet seal assembly (14).

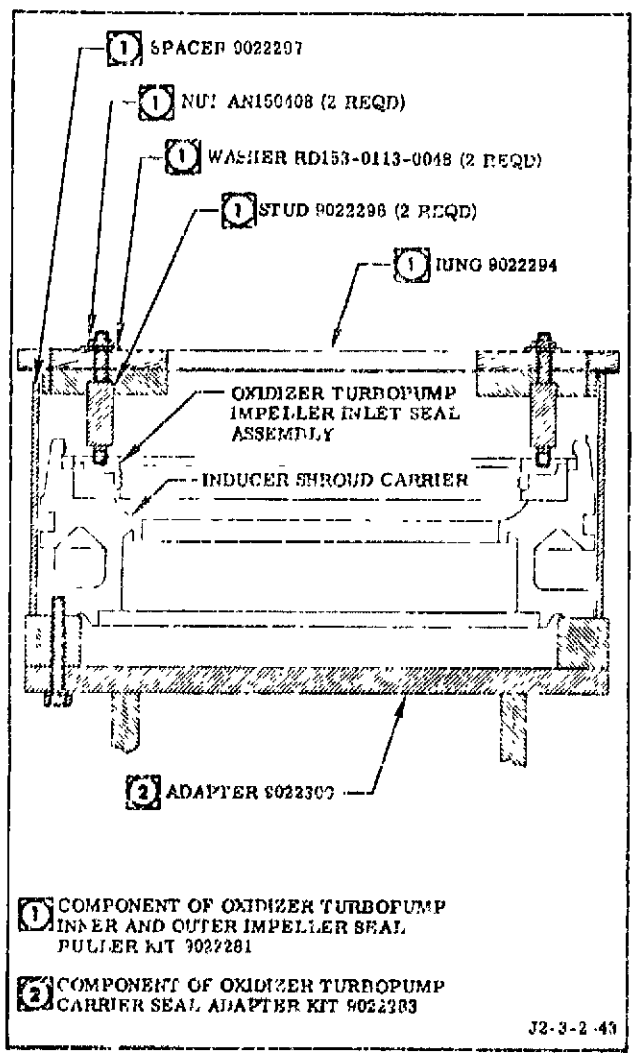


Figure 13-3. GSE Setup for Impeller Inlet Seal Assembly

13-7. REMOVING INDUCER. (See figure 13-1.) The inducer cannot be replaced without affecting engine calibration. Parts replacement is limited to attaching hardware (15, 16).

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain a shaft countertorque wrench kit 9021803 or wrench T-5044537 and an oxidizer turbopump inducer bolt spanner wrench kit 9022280.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove oxidizer inlet duct. Refer to R-3825-3, Volume I.

d. Remove accessory drive pad cover plate, (if hydraulic pump is installed, also remove quill shaft using stage contractor procedures) and install shaft countertorque wrench kit 9021803 or wrench T-5044537. (See figure 13-4.) Make sure adapter straddles turbine wheel bolt heads and is held securely against turbine wheel bolt locktabs, tighten setscrews handtight, and torque nuts securing retainer to heat exchanger duct to 100-150 in-lb.

e. Straighten tab or tabs on inducer bolt lockwasher (16) that are bent into slot on inducer bolt (15) bolthead. Make sure tab on inducer bolt lockwasher (16) is bent into slot on inducer (17).

f. Using spanner wrench 9022293 (inducer bolt spanner wrench kit 9022280) remove inducer bolt (15) and inducer bolt lockwasher (16). Use care to prevent rotation of lockwasher (16) relative to inducer (17). Discard lockwasher (16).

g. Remove inducer (17).

13-8. REMOVING IMPELLER. (See figure 13-1.) The impeller cannot be replaced without affecting engine calibration.

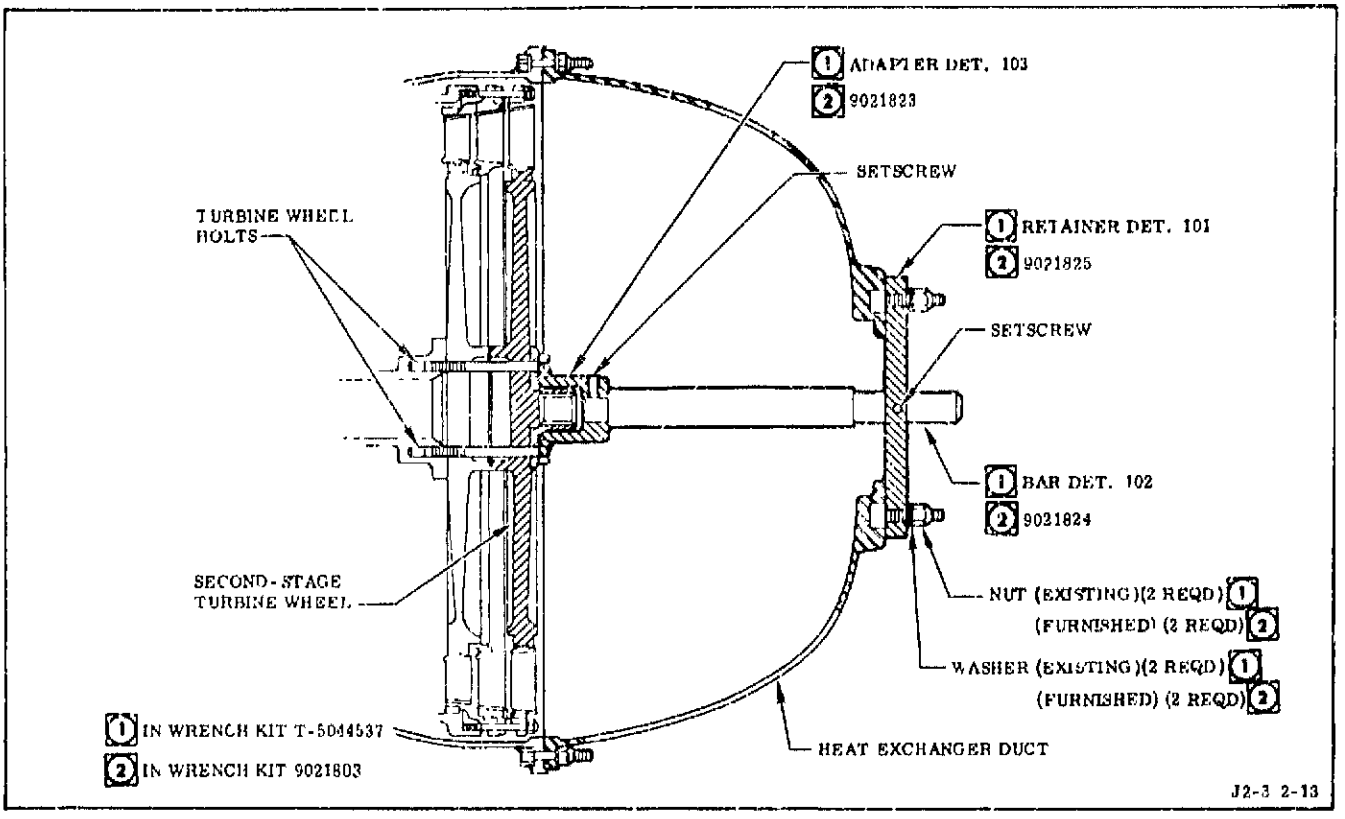


Figure 13-4. GSE Setup for Turbopump Shaft Countertorque

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain a bearing nut torque wrench kit 9021816 or a special socket T-5026253.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove inducer shroud carrier (paragraph 13-4) and inducer (paragraph 13-7).

d. Remove impeller (6).

e. Using bearing nut torque wrench 9021817 (bearing nut torque wrench kit 9021816) or special socket T-5026253, slowly apply a clockwise torque to oxidizer bearing nut until a torque of 125-150 ft-lb is obtained. Apply torque clockwise only. Do not loosen and retorque oxidizer bearing nut.

13-9. REMOVING IMPELLER OUTLET (INNER) SEAL ASSEMBLY. (See figure 13-1.) The impeller outlet seal assembly cannot be replaced without affecting engine calibration. Parts replacement is limited to attaching hardware (1, 2).

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain an oxidizer turbopump inner impeller seal retaining nut spanner wrench kit 9022282.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove inducer shroud carrier (paragraph 13-4), inducer (paragraph 13-7), and impeller (paragraph 13-8).

d. Straighten tabs on impeller outlet seal nut lockring (2).

e. Matchmark impeller outlet seal assembly (3) to volute (7).

f. Using spanner wrench kit 9022282 (figure 13-5), remove outlet seal retaining nut (1).

g. Using impeller seal puller kit 9022281 (figure 13-6), remove impeller outlet seal assembly (3).

h. Remove and discard lockring (2).

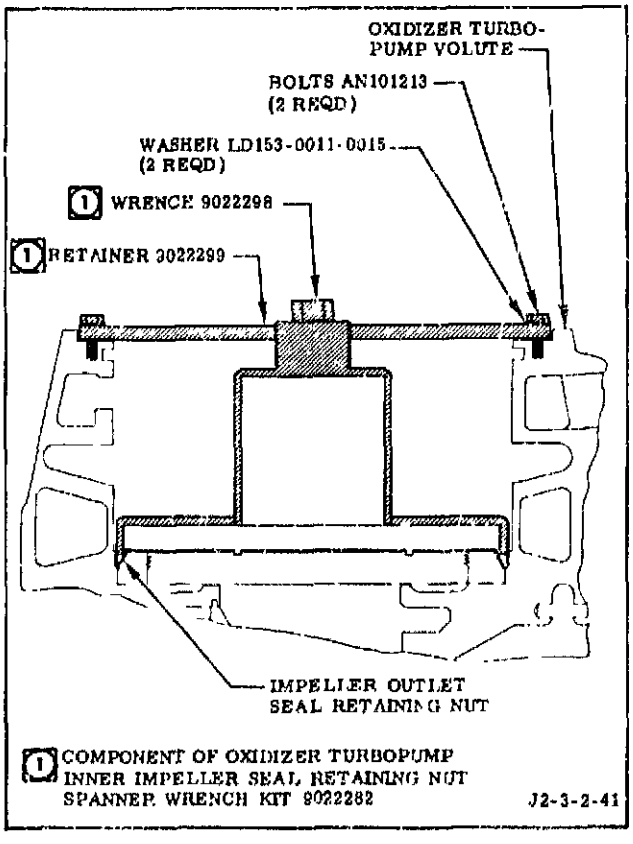


Figure 13-5. GSE Setup for Impeller Outlet Seal Retaining Nut

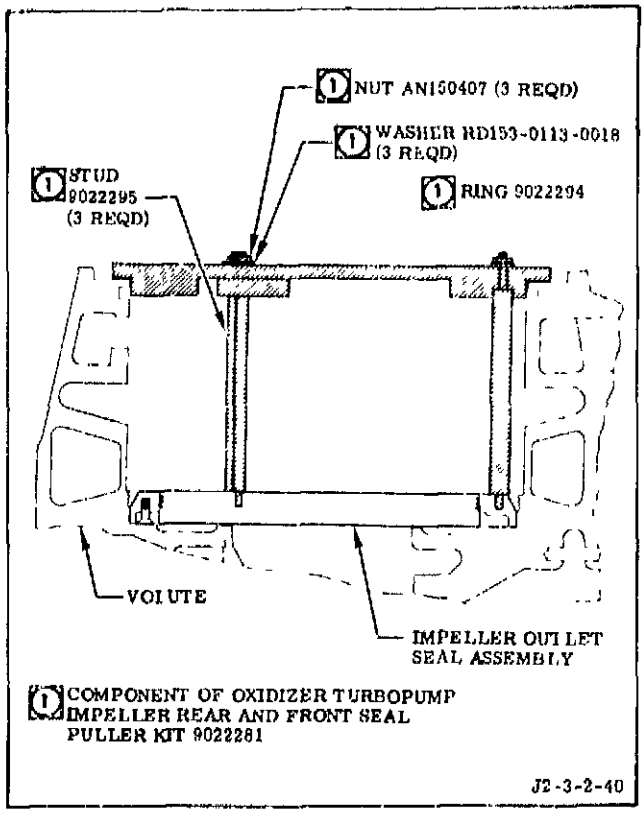


Figure 13-6. GSE Setup for Impeller Outlet Seal Assembly

13-10. INSPECTING AND REPAIRING PUMP-END COMPONENTS.

13-11. Figure 13-7 provides mandatory inspection and allowable repair for specified components. All components removed from the pump end of the oxidizer turbopump must be visually inspected for damage before installation. Components not removed must be visually inspected for damage to the degree possible in their installed state. Notify Rocketdyne Representative of damage other than that for which repair is provided in figure 13-7.

13-12. CLEANING PUMP-END COMPONENTS.

13-13. Pump-end components must be verified as being clean for propellant service or must be cleaned for propellant service as outlined in R-3825-3, Volume I before being installed.

Nomenclature and Index No. (Figure 13-1)	Inspection	Disposition
Impeller (6)	Material protruding from leading edge of vanes.	Remove protruding material and chemically treat reworked areas. (Refer to repairing anodic-coated surfaces in R-3825-3, Volume I.)
	Erosion.	Chemically treat erosion that is 2.5 inches or further from axial centerline or within 2 inches of leading edge of vanes and does not exceed 0.020 inch in depth. (Refer to repairing anodic-coated surfaces in R-3825-3, Volume I.)
	Dye-penetrant.	Cracks unacceptable.
Inducer (17)	Material protruding beyond outer rim of vanes.	Remove, using crocus cloth, and chemically treat reworked areas. (Refer to repairing anodic-coated surfaces in R-3825-3, Volume I.)
	Surface erosion.	Chemically treat erosion that is 2.5 inches or further from axial centerline, not on leading edge of vanes, does not exceed 0.025 inch in depth, and does not exceed the following surface areas: a. Two square inches per vane (excluding trailing edge erosion). b. One-half square inch per vane on trailing edge. (Refer to repairing anodic-coated surfaces in R-3825-3, Volume I.) NOTE Leading edge is that portion of vane not of full diameter.
	Material eroded from trailing edge.	Blend eroded surfaces (to a maximum of 0.100 inch from original edge) maintaining 0.12 inch trailing edge radius. Remove any overhanging material. Chemically treat reworked surfaces. (Refer to repairing anodic-coated surfaces in R-3825-3, Volume I.)
Inducer Shroud (21)	Rub marks.	Acceptable if they do not exceed 0.005 inch in depth.
	Dye-penetrant.	Cracks unacceptable.

Figure 13-7. Inspection and Repair of Pump-End Components

13-14. ASSEMBLING PUMP END.

13-15. Paragraphs 13-16 through 13-21 provide procedures for installing pump-end components shown in figure 13-1.

13-16. INSTALLING IMPELLER OUTLET (INNER) SEAL ASSEMBLY. (See figure 13-1.) The impeller outlet seal assembly cannot be replaced without affecting engine calibration. Parts replacement is limited to attaching hardware (1,2).

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

NOTE

Whenever this procedure requires measuring, the dimensions shown in figure 13-8 must be taken and all measurements taken to four decimal places.

a. Obtain an oxidizer turbopump inner impeller seal retaining nut spanner wrench kit 9022282.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Measure and record dimension A.

d. Measure thickness of impeller outlet seal assembly (3) and record as dimension C.

e. Subtract dimension C from dimension A and record difference as dimension B.

f. Install impeller outlet seal nut lockring (2).

g. Install impeller outlet seal assembly (3), alining matchmarks made at disassembly.

h. Engage outlet seal retaining nut (1) with mating threads in volute (7) and handtighten nut (1).

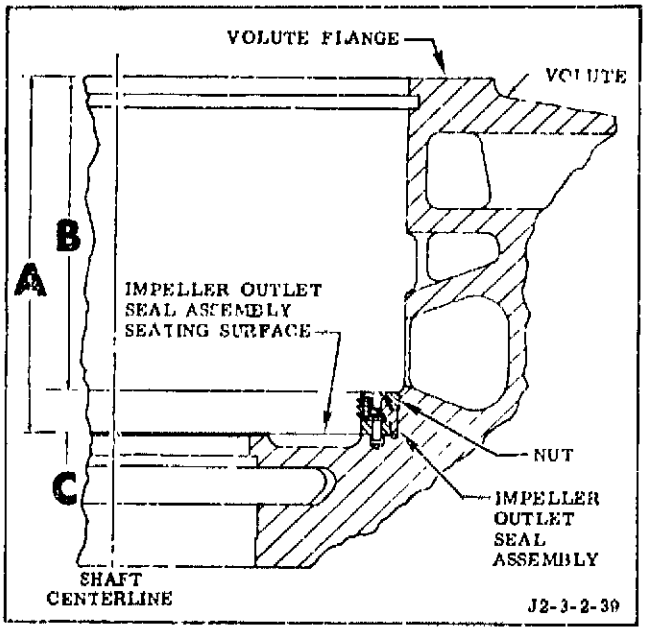


Figure 13-8. Dimensional Requirements for Installing Impeller Outlet Seal Assembly

i. Using spanner wrench kit 9022282 (figure 13-5), rotate retaining nut (1) clockwise until a pair of notches on nut (1) aline with lockring (2) tabs and torque is 100 ±50 ft-lb.

j. Make sure impeller outlet seal assembly (3) is fully seated by measuring dimension B and comparing it with dimension B calculated in step e. Actual and calculated dimensions equal within 0.001 inch ensure that seal assembly is fully seated.

k. Bend lockring (2) tabs into grooves on retaining nut (1).

l. Install impeller (paragraph 13-17).

13-17. INSTALLING IMPELLER. (See figure 13-1.) The impeller cannot be replaced without affecting engine calibration.

NOTE

Unless noted otherwise, whenever this procedure requires measuring, the dimensions shown in figure 13-9 must be taken and all measurements taken to four decimal places.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

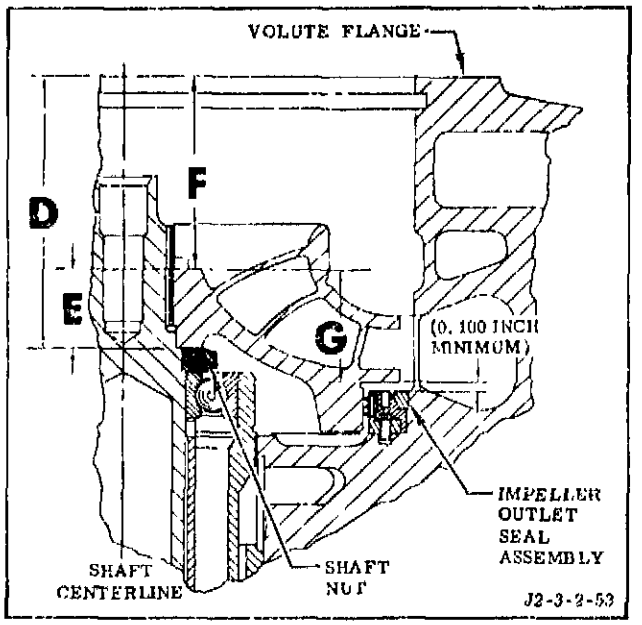


Figure 13-9. Dimensional Requirements for Installing Impeller

b. If dimension B (figure 13-8) has not been previously obtained, measure and record dimension B.

c. Measure and record impeller dimensions E and G.

d. With turbopump shaft fully toward turbine, measure and record dimension D.

e. With B balance matchmarks on impeller and shaft alined, install impeller (6) on shaft fully against shaft nut.

f. Make sure impeller is bottomed on shaft nut by measuring (with shaft fully toward turbine) and recording dimension F, adding dimensions E and F, and comparing sum with dimension D. Dimensions equal within 0.001 inch ensure that impeller is seated on shaft nut.

g. Make sure clearance of 0.100 inch minimum exists between impeller (6) and impeller outlet seal assembly (3) by adding dimensions F and G, and subtracting sum from dimension B. Difference must be equal to or greater than 0.100 inch.

h. Install inducer shroud carrier (paragraph 13-21).

13-18. INSTALLING INDUCER. (See figure 13-1.) The inducer cannot be replaced without affecting engine calibration. Parts replacement is limited to the attaching hardware (15, 16).

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

NOTE

Unless noted otherwise, whenever this procedure requires measuring, the dimensions shown in figure 13-10 must be taken and all measurements taken to four decimal places.

a. Obtain a shaft countertorque wrench kit 9021803 or wrench T-5044537, an oxidizer turbopump inducer bolt spanner wrench kit 9022280, and an oxidizer turbine accessory drive torquing wrench kit 9016712-11.

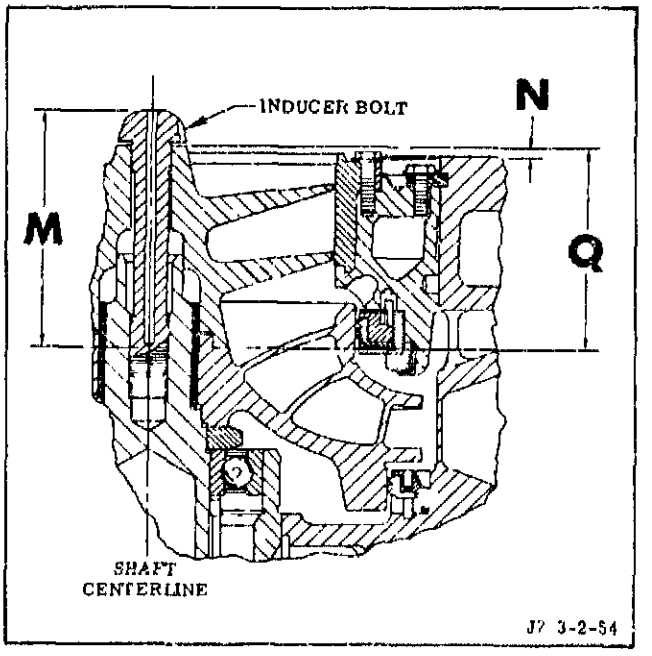


Figure 13-10. Dimensional Requirements for Installing Inducer

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Measure overall height of inducer (17) and record as dimension Q.

d. With matchmarks on inducer (17) and shaft alined, install inducer (17) fully (bottomed against impeller) on shaft.

e. Measure and record dimension N.

f. If dimension F (figure 13-9) has not been previously obtained, measure and record dimension F.

g. Make sure inducer (17) has bottomed on impeller by adding dimensions F and N and comparing sum with dimension Q. Dimensions equal within 0.001 inch ensure that inducer (17) is bottomed on impeller (6).

h. If shaft countertorque wrench kit 9021803 or wrench T-5044537 is installed (figure 13-4) omit this step, otherwise remove accessory drive pad cover plate (if hydraulic pump is installed, also remove quill shaft using stage contractor procedures), and install shaft countertorque wrench kit 9021803 or wrench T-5044537. Make sure adapter straddles turbine wheel bolts and is held securely against turbine wheel locktabs, tighten setscrews hand-tight, and torque nuts securing retainer to heat exchanger duct to 100-150 in-lb.

i. Measure depth of hole in inducer bolt (15) and record as dimension M.

j. Apply (Method V, R-3825-3, Volume I) Molykote Type Z powder (Dow Corning Corp) on threads of inducer bolt (15).

k. Bend one tab on inducer bolt lockwasher (16); then install lockwasher (16) on inducer bolt (15) with bent tab inserted in a slot on inducer bolt head. Install inducer bolt lockwasher (16) and inducer bolt (15) and tighten bolt fingertight.

l. Using inducer bolt spanner wrench 9022293 (inducer bolt spanner wrench kit 9022280) torque inducer bolt (15) until inducer bolt (15) is elongated 0.008 +0.001 inch, an unused tab on inducer bolt lockwasher (16) alines with a slot on inducer (17), and torque does not exceed 225 ft-lb. Determine inducer bolt (15) elongation by measuring dimension M and subtracting from it the dimension M recorded in step i. If alinement of a lockwasher (16) tab with an inducer (17) slot is not attained within the allowable elongation of inducer bolt (15), determine which slot on inducer bolt (15) that bent tab should be in for alinement, loosen inducer bolt (15), reposition lockwasher (16), and repeat this step. Do not exceed 225 ft-lb torque on inducer bolt (15), since damage to inducer bolt (15) and/or turbopump shaft may result.

m. Bend tab on inducer bolt lockwasher (16) into alined slot on inducer (17).

n. Remove shaft countertorque wrench kit 9021803 or wrench T-5044537 from heat exchanger duct.

CAUTION

Exceeding 1,000 in-lb when checking turbopump breakaway torque can damage turbopump.

o. Using oxidizer turbine accessory drive torquing wrench kit 9016712-11 and a 0-1,000 in-lb torque wrench, determine ambient shaft breakaway and turning torque. Torque necessary to start turbopump rotating (breakaway) must not exceed 1,000 in-lb. Torque necessary to maintain turbopump rotating (turning) must not exceed 200 in-lb.

p. Install accessory drive pad cover plate with nuts and washers. Torque nuts to 150 +8 in-lb. If hydraulic pump is installed on cover plate, install quill shaft using stage contractor procedures.

13-19. INSTALLING IMPELLER INLET (OUTER) SEAL ASSEMBLY. (See figure 13-1.) The impeller inlet seal assembly cannot be replaced without affecting engine calibration. Parts replacement is limited to the impeller inlet seal retaining nut and nut lockring.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

NOTE

Whenever this procedure requires measuring, the dimensions shown in figure 13-11 must be taken and all measurements taken to four decimal places.

a. Obtain an oxidizer turbopump carrier seal adapter kit 9022283 and a retainer nut spanner wrench kit 9022285.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Measure and record dimension H.

d. Measure thickness of impeller inlet seal assembly (14) and record as dimension J.

e. Add dimensions H and J and record sum as calculated dimension K.

f. Install inducer shroud carrier (12) into adapter 9022300 (oxidizer turbopump carrier seal adapter kit 9022283). Secure with bolts and washers supplied in kit. (See figure 13-3.)

g. Install impeller inlet seal assembly (14), alining matchmarks made during disassembly.

h. Install impeller inlet seal nut lockring (4).

i. Engage impeller inlet seal retaining nut (5) with mating threads in inducer shroud carrier (12) and handtighten nut (5).

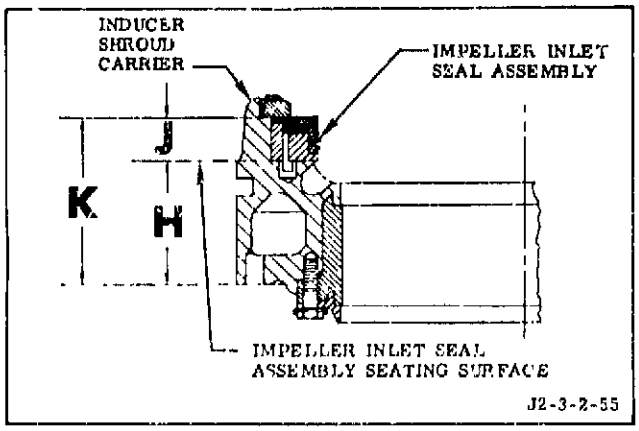


Figure 13-11. Dimensional Requirements for Installing Impeller Inlet Seal Assembly

j. Using wrench 9022301 (retainer nut spanner wrench kit 9022285), torque retaining nut (5) until a pair of notches on nut (5) aline with lockring (4) tabs and torque is 100 ±50 ft-lb.

k. Remove inducer shroud carrier (12) from adapter.

l. Make sure impeller inlet seal assembly (14) is bottomed in inducer shroud carrier (12) by measuring and recording dimension K and comparing it with dimension K calculated in step e. Actual and calculated dimensions equal within 0.001 inch ensure that seal is bottomed.

m. Install inducer shroud carrier (paragraph 13-21).

13-20. INSTALLING INDUCER SHROUD. (See figure 13-1.) Neither the inducer shroud nor the inducer shroud restraining ring can be replaced without affecting engine calibration. Parts replacement is limited to the attaching hardware.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Install inducer shroud (21) and inducer shroud restraining ring (20) in inducer shroud carrier (12), alining matchmarks made during disassembly.

c. Install locktabs (19) and bolts (18). Torque bolts (18) to 25 ±5 in-lb.

d. Bend locktab (19) tabs.

13-21. INSTALLING INDUCER SHROUD CARRIER AND PISTON RING. (See figure 13-1.) The inducer shroud carrier cannot be replaced without affecting engine calibration. Parts replacement is limited to attaching hardware, inlet carrier retainers, and the piston ring.

NOTE

Unless otherwise noted, whenever this procedure requires measuring, the dimensions shown in figure 13-12 must be taken and all measurements taken to four decimal places.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Make sure impeller inlet seal assembly (14) (paragraph 13-19) and impeller (6) (paragraph 13-17) are installed.

c. Install piston ring (13) on inducer shroud carrier (12).

d. Partially install 2 bolts (9), 180 degrees apart, in inducer shroud carrier (12) for use as handhold for installing inducer shroud carrier (12).

e. Install inlet shroud carrier (12) in volute (7), alining matchmarks made during disassembly.

f. Remove bolts installed in step d.

g. Install inlet carrier retainers (11), lock tabs (8,10), and bolts (9). Torque bolts (9) to 60 ±5 in-lb.

h. Bend locktab (8,10) tabs.

i. If inducer (17) was not removed for current maintenance task delete remainder of this procedure.

j. If dimension F (figure 13-9) has not been previously obtained, measure and record dimension F.

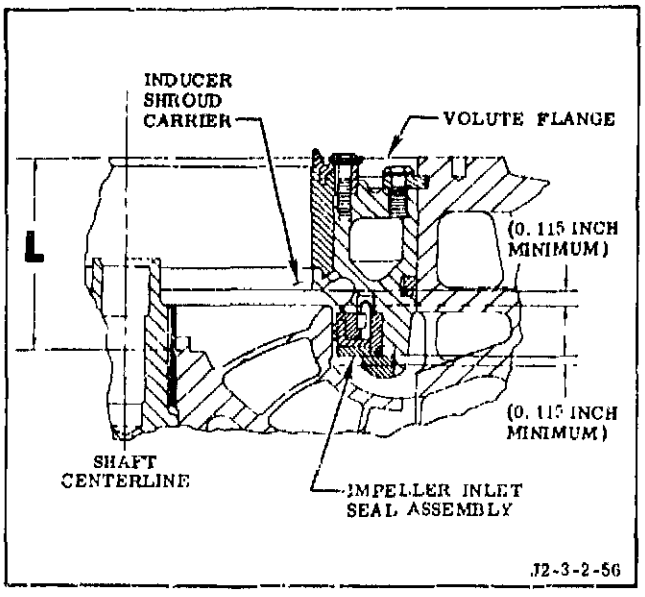


Figure 13-12. Dimensional Requirements for Installing Inducer Shroud Carrier

k. With impeller (6) pulled toward inlet until contact is made that prevents further impeller movement, measure and record dimension L.

l. Make sure a minimum axial clearance exists between impeller (6) and any part of inducer shroud carrier (12) and impeller inlet seal assembly (14) by subtracting dimension L from dimension F. Difference must be equal to or greater than 0.115 inch.

13-22. TESTING AFTER PUMP-END MAINTENANCE.

13-23. Leak test oxidizer feed system. (Refer to R-3825-1B.)

13-24. DISASSEMBLING TURBINE END.

13-25. Figure 13-13 illustrates components of the oxidizer turbopump turbine end that may be removed for field level maintenance. Procedures for removing these components are in paragraphs 13-26 and 13-27.

13-26. REMOVING SECOND-STAGE TURBINE WHEEL. (See figure 13-13.) The second-stage turbine wheel cannot be replaced without affecting engine calibration. Parts replacement is limited to two turbine wheel retaining bolts and the turbine wheel bolt locks.

WARNING

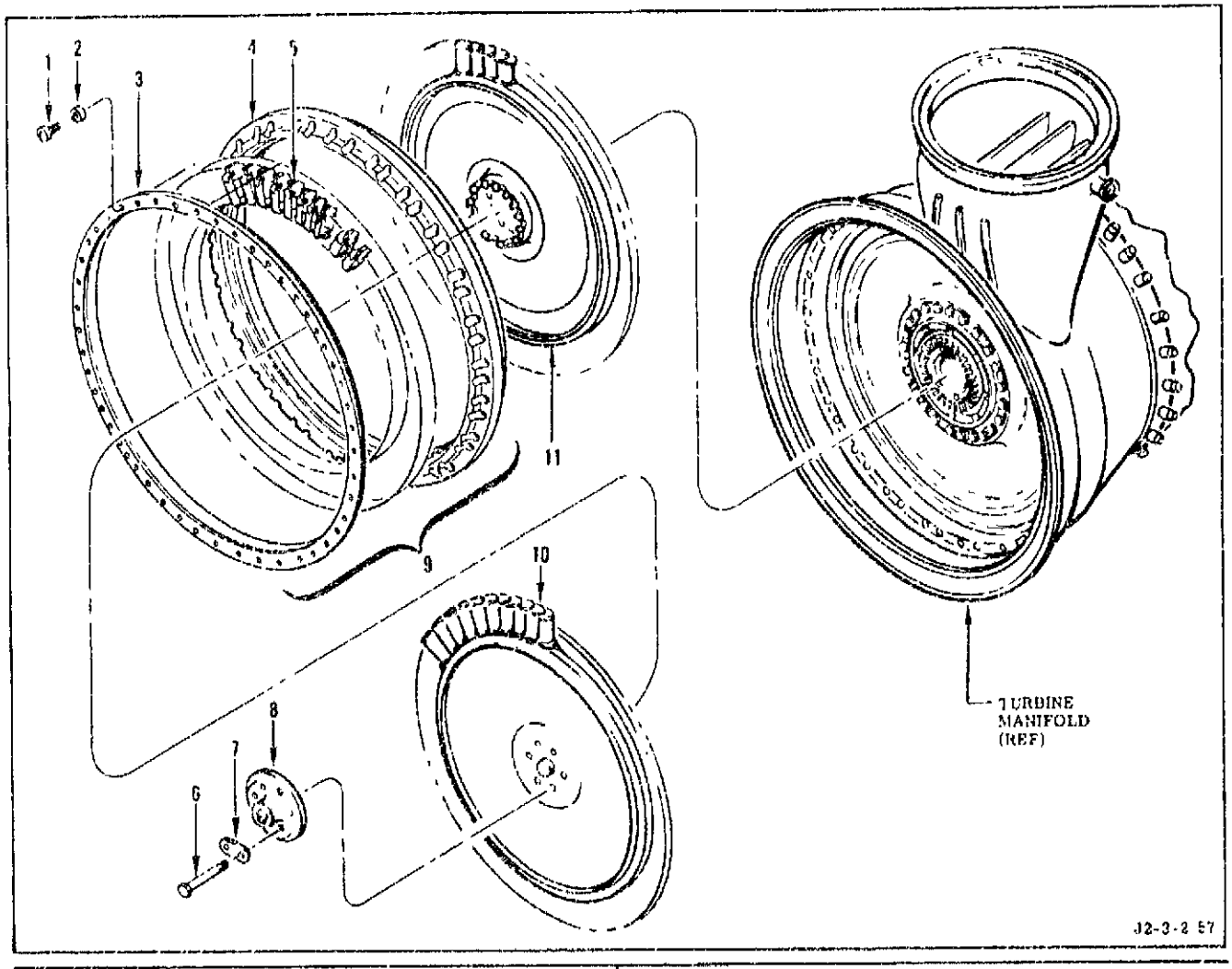
Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain an oxidizer turbine disk removal guide pin kit 9022289.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove heat exchanger. (Refer to R-3825-3, Volume I.)

d. Straighten tabs on turbine wheel bolt locks (7).



Index No.	Nomenclature	Index No.	Nomenclature
1	Turbine Stator Bolt	7	Turbine Wheel Bolt Lock
2	Washer	8	Accessory Drive Adapter
3	Turbine Stator Clamp Ring	9	Turbine Stator Assembly
4	Turbine Stator Mounting Ring	10	Second-Stage Turbine Wheel
5	Turbine Stator Blade	11	First-Stage Turbine Wheel
6	Turbine Wheel Retaining Bolt		

Figure 13-13. Turbine End of Oxidizer Turbopump

e. Remove all but 2 diametrically opposed turbine wheel retaining bolts (6) and a turbine wheel bolt lock (7). Discard bolt lock (7).

f. Install guide pins 9022291 (oxidizer turbine disk removal guide pin kit 9022289) in 2 diametrically opposed holes in second-stage turbine wheel (10).

g. Verify that B balance matchmarks are visible at interface of accessory drive adapter (8) and second-stage turbine wheel (10). If B balance matchmarks are not visible, index-mark relative position of accessory drive adapter (8) and second-stage turbine wheel (10). Do not impression stamp.

h. Holding second-stage turbine wheel to prevent it falling, remove the remaining turbine wheel retaining bolts (6) and turbine wheel bolt locks (7). Discard turbine wheel bolt locks (7). Do not disengage second-stage turbine wheel (1) from guide pins.

NOTE

Second stage turbine wheel is maintained on guide pins until B balance matchmarks between first- and second-stage turbine wheels are visible.

CAUTION

Damage to turbine stator mounting ring (4) and/or first-stage turbine wheel (11) can result if wheel (11) is allowed to drop on mounting ring (4).

i. Carefully move second-stage turbine wheel (10) on guide pins to make sure it is not stuck to first-stage turbine wheel (11). If wheel is free, continue with this procedure, otherwise replace accessory drive adapter and 2 turbine wheel retaining bolts (6) snug, delete the remainder of this procedure, and proceed to turbine stator assembly and first-stage turbine wheel removal (paragraph 13-27).

j. Without disengaging second-stage turbine wheel (10) from guide pins, slowly lower wheel enough to verify that B balance matchmarks are visible at interface of second-stage turbine wheel (10) and first-stage turbine wheel (11). If B balance matchmarks are not visible, index-mark relative position of first- and second-stage wheels. Do not impression stamp.

k. Slowly remove second-stage turbine wheel (10), allowing first-stage turbine wheel (11) to rest on turbine stator mounting ring (4).

13-27. REMOVING TURBINE STATOR ASSEMBLY AND FIRST-STAGE TURBINE WHEEL. (See figure 13-13.) The turbine stator assembly and/or the first-stage turbine wheel cannot be replaced without affecting engine calibration. Parts replacement is limited to attaching hardware.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Remove second-stage turbine wheel (paragraph 13-26).

c. Using turbine inlet as the 12 o'clock reference, remove the 3 equally spaced bolts and washers from 10 o'clock position as viewed from turbine end. Make sure bolts removed measure approximately 2-1/4 inches (shank length). If shorter bolts (approximately 1-3/4-inch shank length) are removed, reinstall shorter bolts and verify that correct bolt pattern is being removed. Torque any reinstalled bolt to 80 ±5 in-lb.

NOTE

Steps d and e remove bolts (2-1/4-inch shank length) that secure the stator assembly to the turbine manifold. Shorter bolts (1-3/4-inch shank length) secure stator components as an assembly.

d. Proceeding clockwise (viewed from turbine end) from removed bolts and washers, remove next bolt and washer. Make sure bolt length complies with requirements of step c.

e. From bolt removed in step d and continuing clockwise, skip one bolt and remove the next 3 bolts and washers, and repeat this sequence of skipping one bolt and removing the next three bolts and washers until the full circle is completed. A total of 34 bolts and washers (including those removed in steps c and d) will be removed. Make sure bolt lengths comply with requirements of step c and that stator assembly is supported as last bolts are removed.

f. Remove stator assembly and first-stage turbine wheel. If second-stage wheel has not been removed (stuck to first-stage wheel) remove turbine wheel retaining bolts (6) and remove stator assembly and first- and second-stage turbine wheels as a unit.

g. If first- and second-stage wheels are stuck to each other they may be separated as outlined in paragraph 13-28.

13-28. SEPARATING FIRST- AND SECOND-STAGE TURBINE WHEELS. (See figure 13-14.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain a turbine wheel separator tool kit 9021806 or a wheel puller kit T-5035008.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Place first-stage turbine wheel, stator assembly, and second-stage turbine wheel on a flat surface with second-stage turbine wheel on top.

d. Assemble turbine wheel separator tool kit or wheel puller kit as shown in figure 13-14. Place push rods and studs with their associated locks in alternate holes.

e. Tighten bolt until wheels separate. Do not remove second-stage wheel or disassemble GSE.

NOTE

Relative position of the first- and second-stage turbine wheel is maintained until B balance matchmarks between first- and second-stage turbine wheels are visible.

f. Without disengaging second-stage turbine wheel from GSE, raise wheel enough to verify that B balance matchmarks are visible at interface of second-stage turbine wheel and first-stage turbine wheel. If B balance matchmarks are not visible, index-mark relative position of first- and second-stage wheels. Do not impression stamp.

g. Remove wheel puller.

13-29. DISASSEMBLING TURBINE STATOR ASSEMBLY. (See figure 13-13.) The turbine stator clamp, turbine stator mounting ring, and/or turbine stator blades cannot be replaced without affecting engine calibration. Parts replacement is limited to assembly hardware (1,2).

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Remove bolts (1) and washers (2).

c. Separate turbine stator clamp (3), turbine stator blades (5), and turbine stator mounting ring (4).

13-30. INSPECTING AND REPAIRING TURBINE-END COMPONENTS.

13-31. Figure 13-15 provides mandatory inspection and allowable repair for specified components. All components removed from the oxidizer turbopump turbine end must be visually inspected for damage before installation. Components not removed must be visually inspected for damage to the degree permissible in their installed state. Notify Rocketdyne Representative of damage other than that for which repair is provided in figure 13-15.

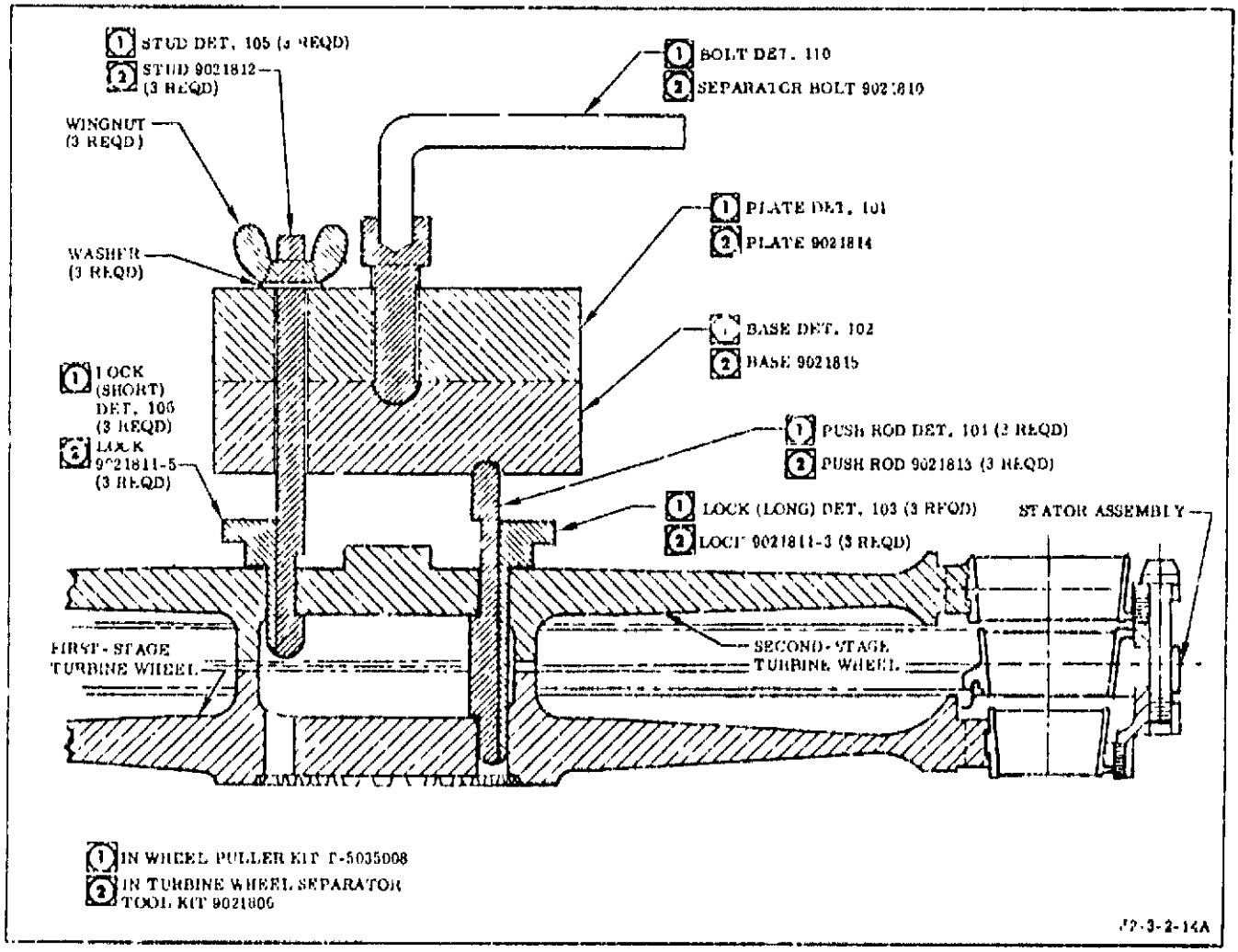


Figure 13-14. GSE Setup for Separating Turbine Wheels

Nomenclature and Index No. (Figure 13-13)	Inspection	Disposition
First- and second-stage turbine wheels (10,11)	Broken tabs on turbine blade locks. (See figure 13-16.)	A total of 54 broken first-stage and 48 broken second-stage blade locktabs are acceptable, if not more than 4 adjacent locktabs are broken. If specified limits are exceeded, notify Rocketdyne Representative.
	Disks for cracks.	
	a. Visually	Replace turbopump.
	b. Dye-penetrant method as outlined in R-3825-3, Volume I.	Replace turbopump.
	Leading and trailing edges of rotor blades for rubbing.	Rub marks less than 0.010 inch deep are acceptable. If rub marks are 0.010 to 0.020 inch deep, notify Rocketdyne Representative. If rub marks exceed 0.020 inch deep, the turbopump must be repaired. Notify Rocketdyne Representative.
Stator assembly (9)	Rubbing on blade leading and trailing edges, torn honeycomb, and failure of bond between honeycomb ribbon and backup ring. (See figure 13-17.)	Rub marks less than 0.025 inch deep are acceptable. If rub marks are 0.025 to 0.050 inch deep, notify Rocketdyne Representative. If rub marks exceed 0.050 inch deep, turbopump must be repaired. Notify Rocketdyne Representative. Grooves in honeycomb caused by rubbing of blade tips are acceptable.
	Damaged or missing stator sheet metal seals. (Figure 13-17.)	If more than 11 seals are partially or completely missing, replace discrepant stator blades. Rubbing of sheet metal seals is acceptable.
Turbine manifold	Warped or pitted nozzle vanes.	Depressions (pitting on turbine nozzle vanes are acceptable, with the following conditions: a. If surface depressions are present 0.03 inch upstream of trailing edges of vanes, notify Rocketdyne Representative. b. If surface depressions exceed 0.010 inch deep, notify Rocketdyne Representative.

Figure 13-15. Inspection and Repair of Turbine-End Components (Sheet 1 of 2)

Nomenclature and Index No. (Figure 13-13)	Inspection	Disposition
Turbine manifold (continued)	Raised or loose material.	Remove raised or loose material.
	Inner and outer shrouds and vane trailing edges for evidence of rubbing. (See figure 13-18.)	Rub marks less than 0.010 inch deep are acceptable. If rub marks are 0.010 to 0.020 inch deep, notify Rocketdyne Representative. If rub marks exceed 0.020 inch deep, turbopump must be repaired. Notify Rocketdyne Representative.

Figure 13-15. Inspection and Repair of Turbine-End Components (Sheet 2 of 2)

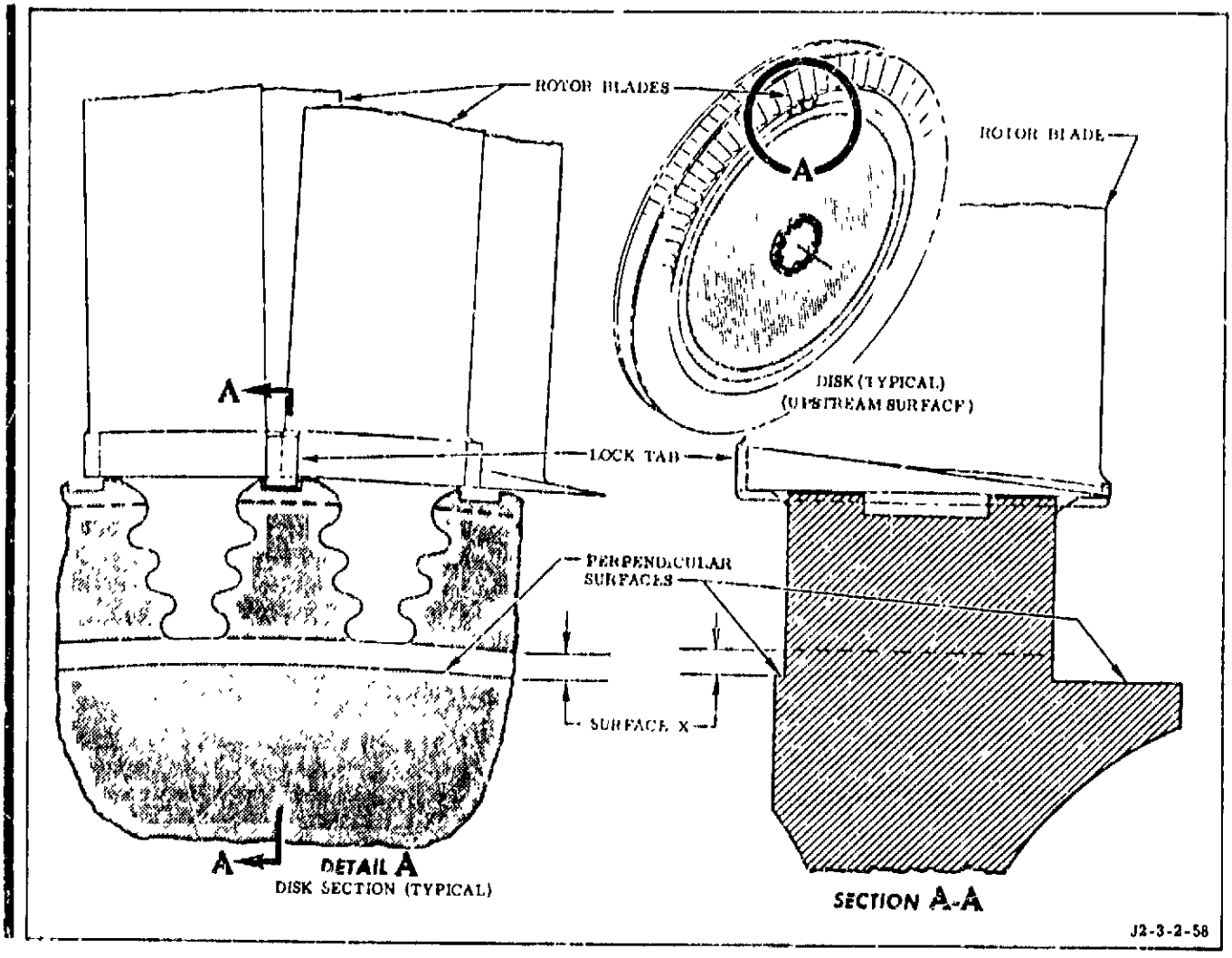


Figure 13-16. Inspection of Turbine Wheel Disks

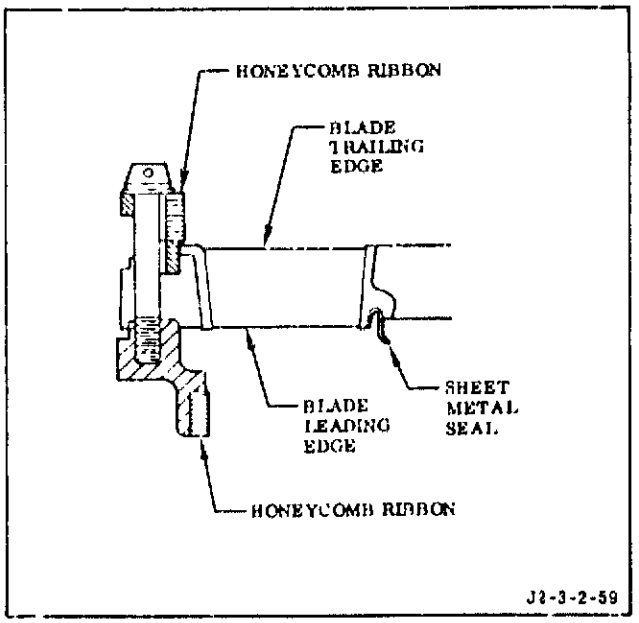


Figure 13-17. Inspection of Stator Assembly

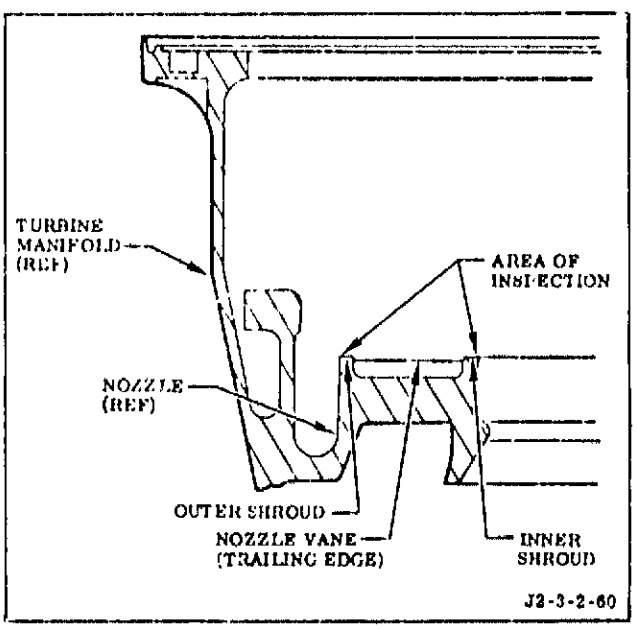


Figure 13-18. Inspection of Turbine Manifold

13-32. CLEANING TURBINE-END COMPONENTS.

13-33. Turbine-end components are cleaned by handwiping with a clean lint-free cloth moistened with any of the following solvents:

a. Cleaning compound (MIL-C-81302).

b. Cleaning solvent (MFSC-SPEC-237).

c. Trichloroethylene (MIL-T-27602).

d. Trichloroethane (MIL-T-81533).

WARNING

Cleaning compound (MIL-C-81302) and cleaning solvent (MSFC-SPEC-237) are volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

- Trichloroethylene and trichloroethane are toxic solvents. Inhalation of their vapors or prolonged contact with the liquid can cause serious injury or death.

13-34. ASSEMBLING TURBINE STATOR ASSEMBLY. (See figure 13-13.) The turbine stator clamp, turbine stator mounting ring, and/or turbine stator blades cannot be replaced without affecting engine calibration. Parts replacement is limited to assembly hardware (1, 2).

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain an oxidizer turbine stationary blade stacking fixture kit 9022278.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Place ring from stacking fixture kit 9022278 on a flat surface with chamfered edge up.

d. Position turbine stator mounting ring (4) around fixture ring with honeycomb seal facing up.

e. Stack turbine stator blades (5) on mounting ring (4), with concave side of airfoil facing clockwise.

f. Position turbine stator clamp ring (3), with honeycomb seal facing up, over stacked stator blade assemblies, alining the 3 equally spaced boltholes with those in turbine stator mounting ring (4). Make sure all stator blade assemblies are mated in turbine stator mounting ring (4).

g. Install 11 bolts (1), approximately 1-3/4-inch shank length, with washers (2) through turbine stator clamp ring (3) and into threaded holes in turbine stator mounting ring (4). Install bolts fingertight.

NOTE

Bolts are left fingertight since it may be necessary to reposition washers (2) when stator assembly is installed.

13-35. INSTALLING TURBINE STATOR ASSEMBLY AND FIRST-STAGE TURBINE WHEEL. (See figure 13-13.) The turbine stator assembly and/or the first-stage turbine wheel cannot be replaced without affecting engine calibration. Parts replacement is limited to attaching hardware.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain an oxidizer turbine disk removal guide pin kit 9022289.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Install guide pins 9022291 (oxidizer turbine disk removal guide pin kit 9022289) in 2 diametrically opposed holes in turbopump shaft.

d. With B balance matchmarks on first-stage turbine wheel and turbopump shaft alined, install turbine wheel over guide pins and against shaft. Hold turbine against shaft by installing 2 bolts (6) fingertight. Use spacers as necessary to compensate for bolt length.

e. With the 3 equally spaced boltholes in stator assembly (9) and turbine manifold alined, install stator assembly and secure it with bolts (1) and washers (2).

f. Torque all bolts (1) through stator assembly (9), 45 bolts, to 80 ±5 in-lb. (Refer to R-3825-3, Volume I.)

g. Safetywire bolts (1). (Refer to R-3825-3, Volume I.)

13-36. INSTALLING SECOND-STAGE TURBINE WHEEL. (See figure 13-13.) The second-stage turbine wheel cannot be replaced without affecting engine calibration. Parts replacement is limited to 2 turbine wheel retaining bolts and the turbine wheel bolt locks.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

b. Make sure stator assembly (9) and first-stage turbine wheel (11) (paragraph 13-35) are installed.

c. While supporting first-stage turbine wheel (11) remove 2 bolts (6) and spacers holding wheel to turbopump shaft and carefully lower wheel until it rests on turbine stator mounting ring (4).

CAUTION

Damage to turbine stator mounting ring (4) and/or first-stage turbine wheel (11) can result if wheel (11) is allowed to drop on mounting ring (4).

d. With B balance matchmarks alined, place accessory drive adapter (8) against second-stage wheel (10) Secure adapter (8) to wheel (10) in this position by passing a turbine wheel retaining bolt (6), with a turbine wheel bolt lock (7), through a bolt hole in adapter and wheel. Select a bolt hole that, when first- and second-stage wheels are alined (B balance matchmarks alined), is not currently occupied by a guide pin.

e. With B balance matchmarks between first- and second-stage turbine wheels (10,11) alined, place second-stage turbine wheel (10) with adapter (8) over guide pins and against first-stage turbine wheel (11). Secure adapter and both wheels to turbopump shaft with bolt (6) installed in step d.

f. Note numbers on turbine wheel retaining bolts (6) bolt heads and install bolts, with turbine wheel bolt locks (7), clockwise in numerical sequence with bolt numbered 1 alined with B balance matchmarks at interface of adapter and second-stage turbine wheel. Remove guide pins to install bolt and, if necessary for numerical sequence, relocate bolt installed in step e.

g. Torque bolts (6) in 50 in-lb increments to 345 +10 in-lb. Torque in a bolt-numbered sequence of 1, 4, 2, 5, 3, and 6.

h. Bend turbine wheel bolt lock (7) tabs.

13-37. TESTING AFTER TURBINE-END MAINTENANCE.

13-38. Testing after turbine-end maintenance consists of checking runout of second-stage turbine wheel and testing the GG and exhaust system.

a. Measure axial runout of second-stage turbine wheel at surface X (figure 13-16). Runout must not exceed 0.006 inch total indicated reading.

b. Test GG and exhaust system. (Refer to R-3825-1B.)

SECTION XIV

PURGE AND SEAL DRAIN CHECK VALVES

WARNING

PNEUMATIC FLOW TESTER G3104 AND COMPONENTS ADAPTER SET 9016796 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

14-1. SCOPE. This section contains preinstallation test requirements for the following purge and seal drain check valves: (Repair information is not included, since the listed check valves are not field repairable.)

Part Number	Use
554078	Oxidizer injector purge
556450	Fuel jacket purge
557751	Fuel turbopump primary seal drain
	Oxidizer turbopump intermediate seal purge
557755	GG fuel purge
	GG oxidizer purge
	Fuel turbine seal purge
	Oxidizer turbine seal purge
	Fuel turbopump primary seal purge
557918-21	Redundant purge check valve manifold 557918-21

14-2. PREINSTALLATION TESTING OXIDIZER INJECTOR PURGE CHECK VALVE 554078.

14-3. The preinstallation test of the oxidizer injector purge check valve consists of reverse leakage and forward flow tests.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment and material, or their equivalents.

(1) Pneumatic test chamber 61312.

(2) Pneumatic Flow Tester G3104.

(3) Hoses, clamps, etc as necessary to connect test chamber to outlet port of check valve. Outlet port is 1.051-inches OD.

(4) Hoses, clamps, etc as necessary to connect test chamber to inlet port of check valve. Inlet port is 0.320-inch OD.

(5) Gaseous helium source, pressurized to a minimum of 35 psig. Helium must conform to pressurizing and purging requirements for helium in R-3825-3, Volume I.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Apply 30 ±5 psig helium pressure to outlet port of check valve and measure leakage from inlet port. Leakage must not exceed 40 scim.

d. Disconnect supply line from outlet port and connect it to inlet port.

e. Slowly apply helium pressure to inlet port until a minimum of 200 scim is flowing from outlet port. Pressure at inlet port must not exceed 20 psig.

f. Secure test equipment and disassemble test setup.

g. Repackage oxidizer injector purge check valve and attach condition tag.

14-4. PREINSTALLATION TESTING FUEL JACKET PURGE CHECK VALVE 556450.

14-5. The preinstallation test of the fuel jacket purge check valve consists of reverse leakage and forward flow tests.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following test equipment and materials, or their equivalents. Items 3 through 5 are in components adapter set 9016796.

(1) Pneumatic test chamber 61312.

(2) Pneumatic Flow Tester G3104.

(3) Fuel jacket purge check valve adapter set 9021887.

(4) Union AN815-4C or reducer AN919 of appropriate size to adapt 1/4 inch port of adapter set to pressurized helium source.

(5) Packing MS28778-4 to seal union or reducer (item 4).

(6) Gaseous helium source, pressurized to a minimum of 35 psig. Helium must conform to pressurizing and purging requirements for helium in R-3825-3, Volume I.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Install fuel jacket purge check valve adapter set on valve. See figure 14-1.

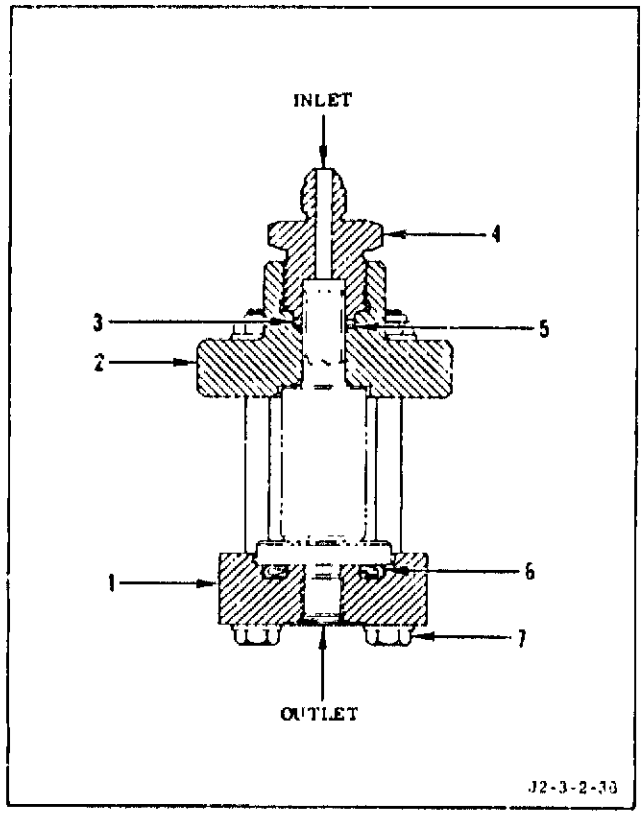


Figure 14-1. Fuel Jacket Purge Check Valve Adapter Set Installation

d. Install union or reducer, as applicable, and packing to adapt outlet port to pressurized helium source. Lubricate (Method J, R-3825-3, Volume I) packing and lubricate (Method A, R-3825-3, Volume I) union or reducer with lubricant grease RB0140-012 (Rocketdyne). Torque union or reducer to 55-80 in-lb.

e. With inlet port open, apply 30 ±5 psig pressure to outlet port of valve and measure leakage from inlet port. Leakage must not exceed 50 scim.

f. Slowly apply pressure to inlet port until a minimum of 5 scfm is flowing from outlet port. Pressure at inlet port must not exceed 30 psig.

g. Secure test equipment and remove valve from adapter set.

h. Repackage check valve and attach condition tag.

14-6. PREINSTALLATION TESTING FUEL TURBOPUMP PRIMARY SEAL DRAIN AND OXIDIZER TURBOPUMP INTERMEDIATE SEAL PURGE CHECK VALVES 557751.

14-7. The preinstallation test for the check valve consists of reverse leakage and forward flow tests.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following test equipment and materials, or their equivalents.

(1) Pneumatic test chamber 61312.

(2) Pneumatic Flow Tester G3104.

(3) Hoses, fittings, clamps, etc, as necessary to adapt pneumatic test chamber to inlet and outlet ports of check valve. Test setup must be capable of withstanding 65 psig pressure. The inlet and outlet ports of the check valve are 0.375 inch and 0.325 inch respectively.

(4) Gaseous helium source, pressurized to a minimum of 70 psig. Helium must conform to the pressurizing and purging requirements for helium in R-3825-3, Volume I.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Apply 30 ±1 psig pressure to outlet port of check valve and measure leakage from inlet port. Leakage must not exceed 20 scim.

d. Apply 30 ±1 psig pressure to inlet port of check valve and measure leakage from outlet port. Leakage must not exceed 25 scim.

e. Increase pressure to inlet port of check valve until a minimum of 2,420 scim is flowing from outlet port. Pressure at inlet port must not exceed 62 psig.

f. Secure test equipment and disassemble test setup.

g. Repackage check valve and attach condition tag.

14-8. PREINSTALLATION TESTING CHECK VALVE 557755. (Refer to paragraph 14-2 for functional uses of check valve 557755.)

14-9. The preinstallation test of the check valve consists of reverse leakage and forward flow tests.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following test equipment and material, or their equivalents.

(1) Pneumatic test chamber 61312.

(2) Hoses (1/4 inch and 3/8 inch-ID), fittings, and clamps to connect check valve to test chamber. Test setup must withstand 40 psig pressure.

(3) Gaseous helium source, pressurized to a minimum of 40 psig. Helium must conform to pressurizing and purging requirements for helium in R-3825-3, Volume I.

(4) Pneumatic Flow Tester G3104.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Apply 30 ±1 psig pressure to outlet port of check valve and measure leakage from valve inlet port. Except for a check valve that is to be used as a GG oxidizer purge check valve, leakage must not exceed 50 scim. GG oxidizer purge check valve leakage must not exceed 12 scim.

d. Slowly apply pressure to inlet port until a minimum of 2,400 scim is flowing from outlet port. Pressure at inlet port must not exceed 36 psig.

e. Secure test equipment and disassemble test setup.

f. Repackage valve and attach condition tag.

14-10. PREINSTALLATION TESTING REDUNDANT PURGE CHECK VALVE MANIFOLD 557918-21.

14-11. The preinstallation test of the redundant purge check valve manifold consists of reverse leakage and forward flow tests.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment and material, or their equivalents:

(1) Pneumatic test chamber 61312

(2) Pneumatic Flow Tester G3104

(3) Gas generator control valve test plate kit 9019969.

(4) Pressure-actuated cryogenic seal 459724.

(5) Union AN815-4C or reducer AN019 of appropriate size to adapt 1/4 inch port of test, plate, and purge kit and purge manifold to pressurized helium source.

(6) Gaseous helium source, pressurized to a minimum of 35 psig. Helium must conform to pressurizing and purging requirements for helium in R-3825-3, Volume I.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Attach test plate from test plate kit to manifold flange using cryogenic seal-to-seal joint. Torque bolts to 41-45 in-lb.

d. Attach pressurized source to test plate kit.

e. With coupling nut on manifold uncapped, slowly apply pressure to test plate until a minimum of one scfm (forward flow) is flowing through manifold. Pressure to test plate must not exceed 21 psig.

f. Reduce pressure to zero, disconnect pressurized source from test plate, and reconnect source to manifold coupling nut.

g. With test plate uncapped, apply 30 ±1 psig to manifold and measure leakage (reverse flow) from test plate. Leakage must not exceed 20 sclm.

h. Secure test equipment and disassemble test setup.

i. Repackage check valve and attach condition tag.

SECTION XV

SOLENOID VALVES

15-1 SCOPE. This section contains preinstallation test requirements for two-, three-, and four-way solenoid valves. Repair information is not included, since solenoid valves are not field repairable.

15-2. PREINSTALLATION TESTING TWO-WAY SOLENOID VALVES 558301, THREE-WAY SOLENOID VALVES NA5-27273 AND NA5-28203, AND FOUR-WAY SOLENOID VALVES 555767 AND 558069.

15-3. The preinstallation test of solenoid valves consists of coil and insulation resistance tests:

a. Obtain the following test equipment, or their equivalents:

(1) Wheatstone bridge or digital ohmmeter (accuracy within ±0.1 ohm).

(2) Valve resistance test selector box 99-9019902.

(3) Strap-on thermometer (accuracy within ±2.0° F).

(4) Insulation resistance tester, 500-vdc (accuracy within ±10 percent and current limited to 10 ma maximum at 500 vdc).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Select test cable that mates with solenoid valve to be tested and attach selected cable to test selector box, connecting leads so that pin A of test cable is connected to jack A, pin B to jack B, etc. Do not connect test cable to solenoid.

d. Attach a test lead from GND jack on test selector box to connector shell of test cable.

e. Connect insulation resistance tester to MEGOHMS jacks on selector box.

f. Turn selector box selector switch to A & B TO GND. Momentarily apply 500 vdc and check insulation resistance. Resistance must be 500 megohms minimum.

g. If test cable 9019946 (basic) is connected, turn selector box selector switch to C TO GND. Momentarily apply 500 vdc and check insulation resistance. Resistance must be 500 megohms minimum.

h. If test cable 9019946 (basic) is connected, turn selector box selector switch to A & B TO C. Momentarily apply 500 vdc and check insulation resistance. Resistance must be 500 megohms minimum.

i. Turn selector box selector switch to OFF.

j. Attach solenoid to be tested to test cable. Make sure GND test lead remains attached to connector shell or attach it to solenoid.

k. Place strap-on thermometer on solenoid case.

l. Connect Wheatstone bridge or digital ohmmeter to OHMS jacks on test selector box.

m. Make sure strap-on thermometer temperature indication has stabilized; note temperature indication.

n. Turn selector box selector switch to A TO B and check resistance indicated on Wheatstone bridge or digital ohmmeter. Resistance must be within limit band shown in appropriate figures 15-1 through 15-3 for temperature noted in step m.

o. Turn selector box selector switch to A & B TO GND. Momentarily apply 500 vdc and check insulation resistance. Resistance must be 50 megohms minimum.

p. If test cable 9019946 (basic) is connected, turn selector box selector switch to C TO GND. Momentarily apply 500 vdc and check insulation resistance. Resistance must be 50 megohms minimum.

q. If test cable 9019446 (basic) is connected, turn selector box selector switch to A & B TO C. Momentarily apply 500 vdc and check insulation resistance. Resistance must be 50 megohms minimum.

r. Turn selector switch to OFF.

s. Secure test equipment and disassemble test setup.

t. Package transducer and attach condition tag.

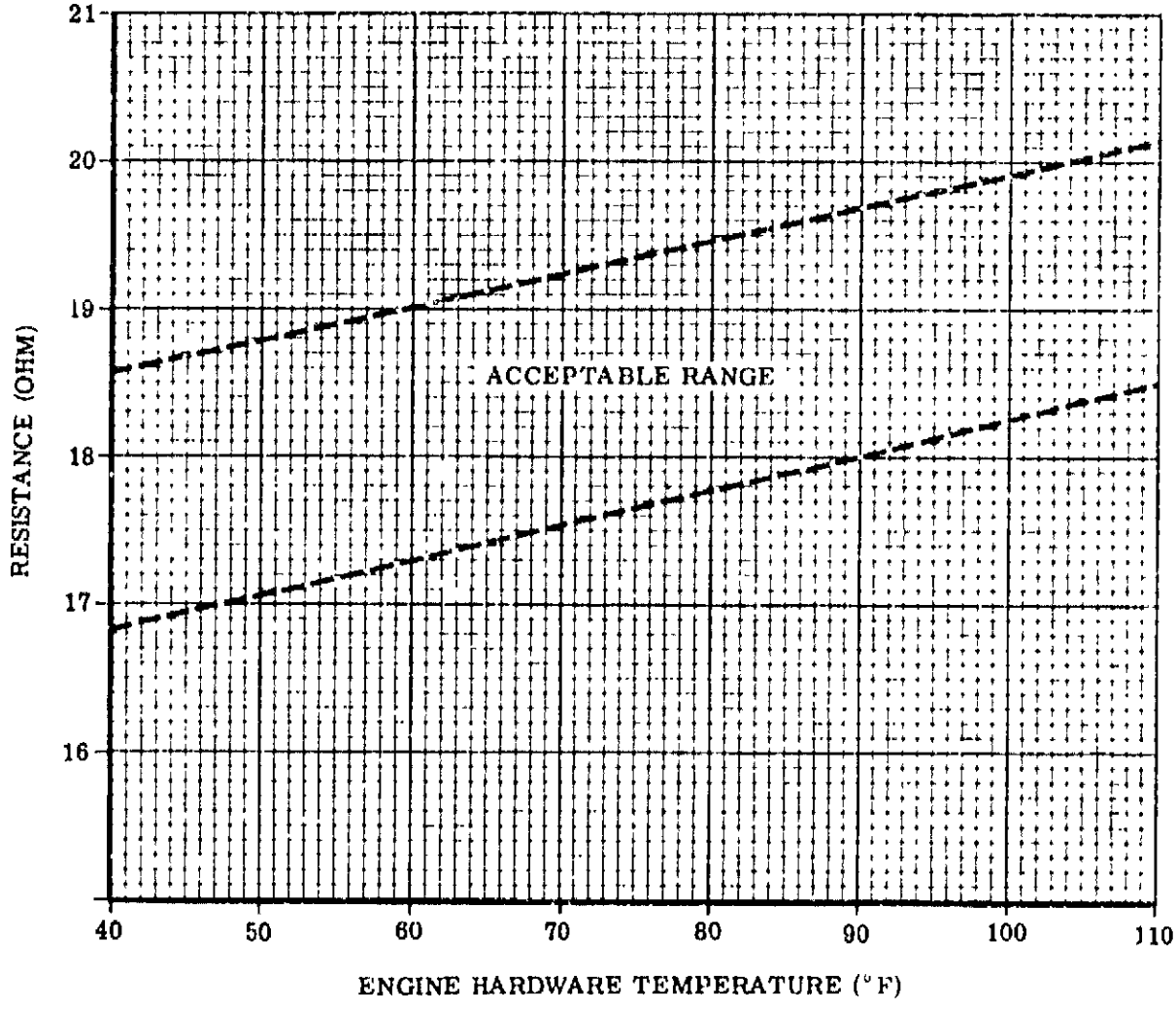


Figure 15-1. Four-Way Valve (Ignition-Phase, Mainstage, and Start Tank Discharge) Solenoid Resistance Limits

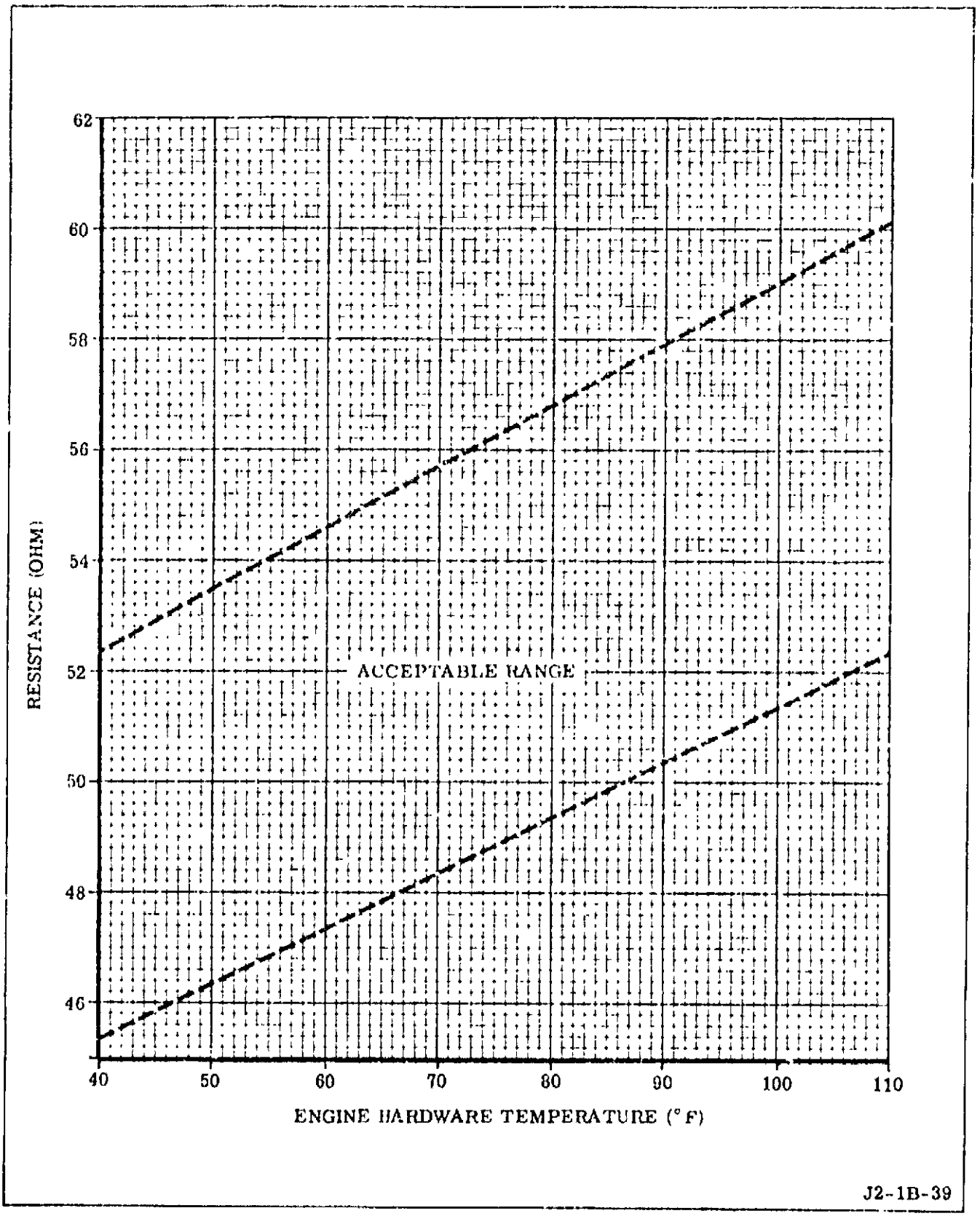


Figure 15-2. Three-Way Valve (Helium Control, Helium Tank Emergency Vent, and Mixture Ratio Control) Solenoid Resistance Limits

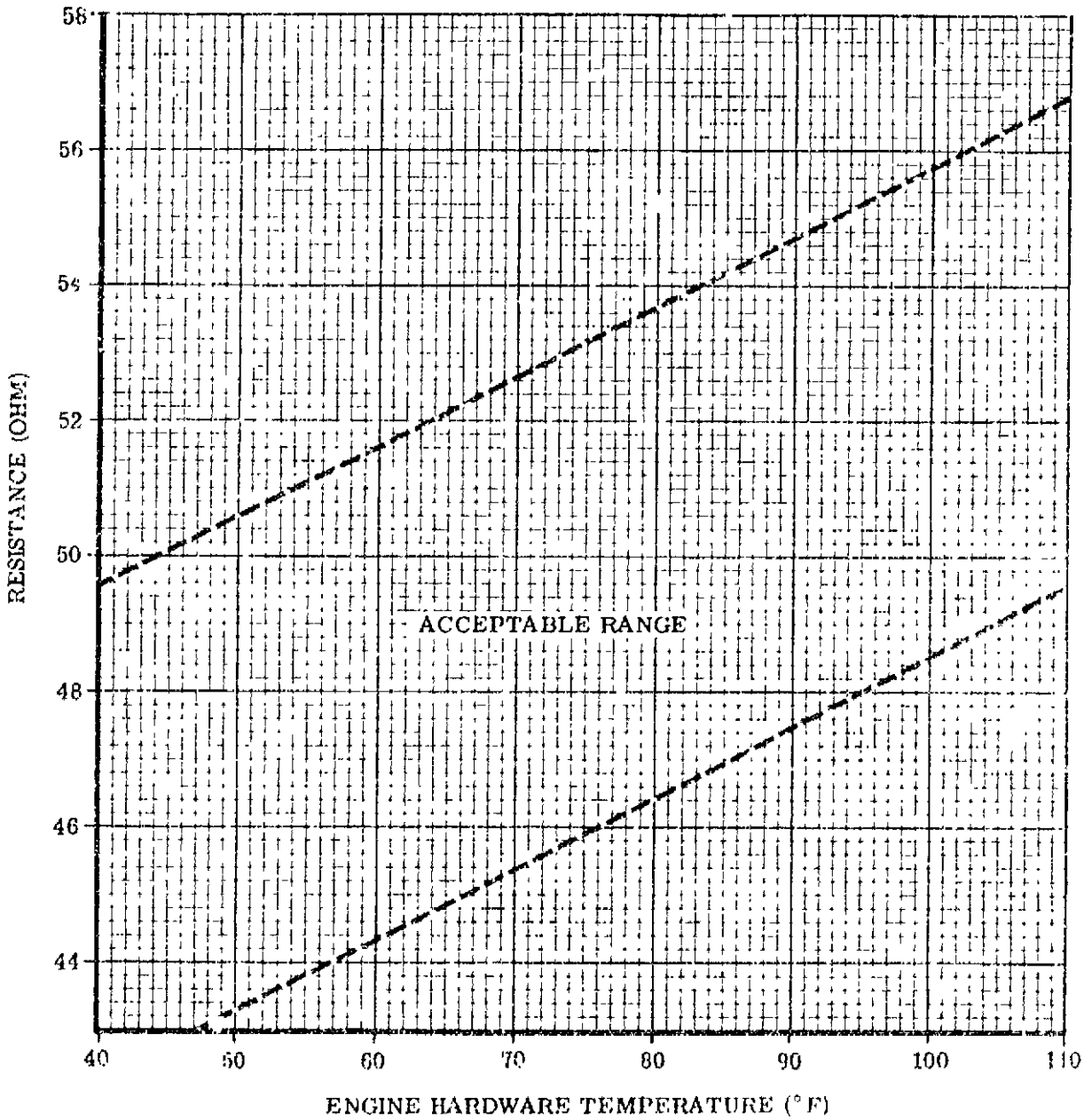


Figure 15-3. Two-Way Valve (Start Tank Emergency Vent) Solenoid Resistance Limits

SECTION XVI

START TANK DISCHARGE VALVE

WARNING

PNEUMATIC FLOW TESTER G3104 AND COMPONENTS ADAPTER SET 9016796 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

16-1. SCOPE. This section contains start tank discharge valve preinstallation test requirements only. Procedures for allowable field repair (parts replacement) are in R-3825-3, Volume I.

16-2. PREINSTALLATION TESTING.

16-3. The preinstallation test consists of a bellows seal leak test.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following test equipment and materials, or their equivalents: (Items 2 and 4 through 6 are in components adapter set 9016796.)

(1) Pneumatic test chamber 61312.

(2) Start tank discharge valve adapter set 9022750.

(3) Pneumatic Flow Tester G3104.

(4) Union AN815-4C or reducer AN919 of appropriate size to adapt 1/4 inch threaded port of test plate to pressurized helium source.

(5) Plug AN814-4C to seal unused test plate port.

(6) Packing MS28778-4 (2 required) to seal union or reducer and plug (refer to items 4 and 5).

(7) Gaseous helium source, pressurized to a minimum of 1,650 psig. Helium must conform to pressurizing and purging requirements for helium found in R-3825-3, Volume I.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

NOTE

Ports referenced in this procedure are identified in figure 16-1.

c. Install plates on ports B and C using associated hardware and seals listed in figure 16-1.

d. Seal port C with plug and packing. Lubricate (Method J, R-3825-3, Volume I) packing and lubricate (Method A, R-3825-3, Volume I) plug with lubricant grease RB0140-012 (Rocketdyne). Torque plug to 40-65 in-lb.

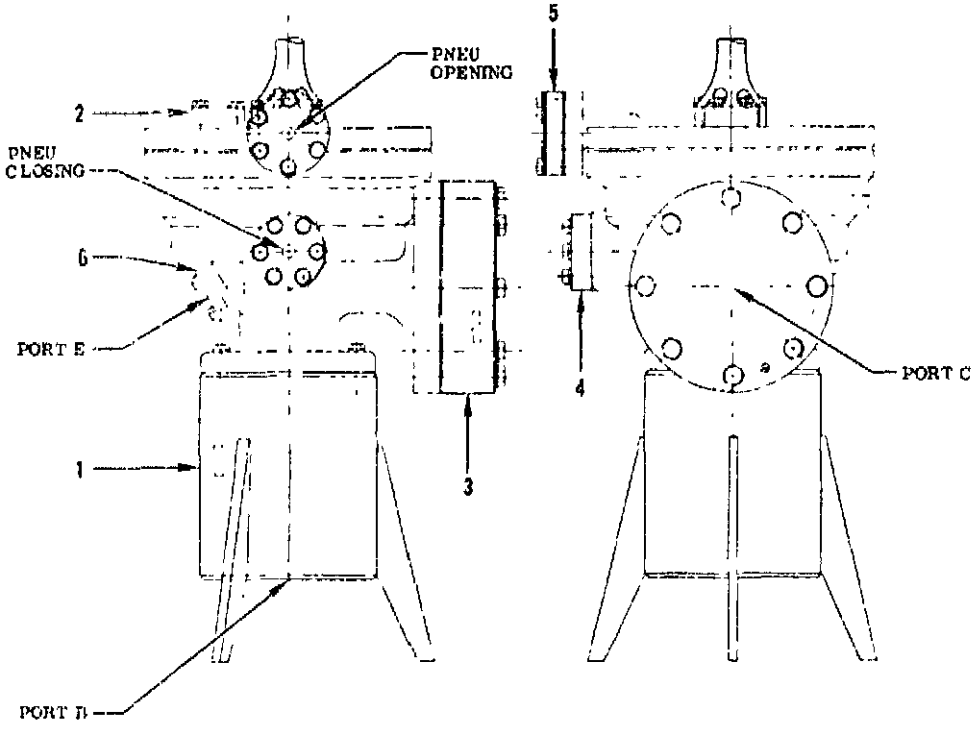
e. Install union or reducer (as applicable) and packing to adapt port B to pressurized helium source. Lubricate (Method J, R-3825-3, Volume I) packing and lubricate (Method A, R-3825-3, Volume I) union or reducer with lubricant grease RB0140-012 (Rocketdyne). Torque union or reducer to 55-80 in-lb.

f. With port E open to atmosphere, apply 1,500 ±50 psig helium pressure to port B for a minimum of 2 minutes; then measure leakage from port E. Leakage must not exceed 5 scim.

g. Repeat step f with 50 ±5 psig helium pressure applied to port B. Leakage must not exceed 5 scim.

h. Secure test equipment and disassemble test setup.

i. Repackage start tank discharge valve and attach condition tag.



Index No.	Description	Quantity Required
1	9022754 Plate	
	RD261-3010-0050 Seal	
	NAS1006-10A Bolt	12
	(Torque to 252-308 in-lb.)	
	RD153-5004-0006 Washer	12
2	9022727 Plate	
	RD261-3010-0012 Seal	
	NAS1004-10A Bolt	4
	(Torque to 68-82 in-lb.)	
	RD153-5004-0004 Washer	4
3	9022752 Plate	
	RD261-3010-0070 Seal	
	NAS1006-29A Bolt	8
	(Torque to 252-308 in-lb.)	
	RD153-5004-0006 Washer	8
4	9022733 Plate	
	RD261-3010-0016 Seal	
	NAS1004-12A Bolt	6
	(Torque to 68-82 in-lb.)	
	RD153-5004-0004 Washer	6
5	9022746 Plate	
	RD261-3010-0018 Seal	
	NAS1004-10A Bolt	6
	(Torque to 68-82 in-lb.)	
	RD153-5004-0004 Washer	6
6	9022536 Plate	
	RD261-3010-0012 Seal	
	NAS1004-10A Bolt	4
	(Torque to 68-82 in-lb.)	
	RD153-5004-0004 Washer	4

Figure 16-1. GSE Setup for Start Tank Discharge Valve

SECTION XVII

START TANK REFILL CHECK VALVE MANIFOLD 307599-41

WARNING

PNEUMATIC FLOW TESTER G3104 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

17-1. SCOPE. This section contains preinstallation test and field repair information for the start tank refill check valve manifold.

17-2. PREINSTALLATION TESTING.

17-3. The preinstallation test of the start tank refill check valve manifold 307599-41 consists of reverse leakage and forward flow tests.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following test equipment and materials, or their equivalents.

(1) Pneumatic test chamber 61312.

(2) Pressure test fixture T-5047149.

(3) Adapter EWR-183647.

(4) Pneumatic Flow Tester G3104.

(5) All items identified with an asterisk (*) in figure 17-1.

(6) Gaseous helium source, pressurized to a minimum of 550 psig. Helium must conform to pressurizing and purging requirements for helium in R-3825-3, Volume I.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Remove orifice from manifold flange.

d. Install manifold in pressure test fixture (see figure 17-1).

e. Slowly apply helium pressure to inlet port (flanged end) until a minimum of 200 scim is flowing from outlet port. Pressure at inlet port must not exceed 37 psig.

f. Apply 500 ±20 psig pressure to outlet port and measure leakage from inlet port. Leakage must not exceed 2 scim.

g. Secure test equipment and remove start tank refill check valve manifold from pressure test fixture.

h. Install orifice in flange. Torque to 25 ±5 in-lb. After torquing, orifice must not protrude more than 0.245 inch from flange.

i. Repackage start tank liquid refill check valve manifold and attach condition tag.

17-4. REPAIRING.

17-5. Field repair of the start tank refill check valve manifold consists of replacing the orifice installed in the flange. No special instructions are required except that the orifice is threaded, is torqued to 25 ±5 in-lb, and must not protrude more than 0.245 inch from flange sealing surface when fully torqued.

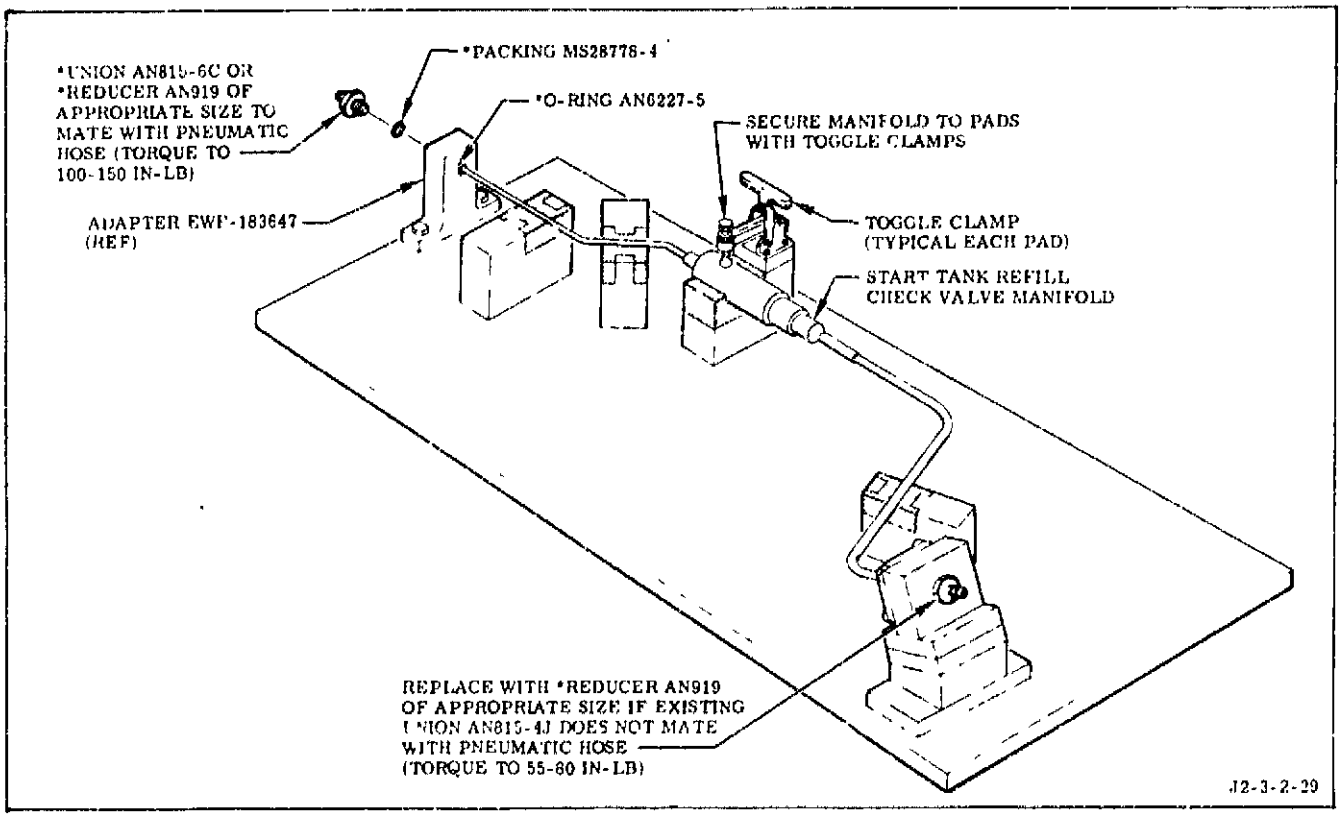


Figure 17-1. GSE Setup for Start Tank Refill Check Valve Manifold

SECTION XVIII

START TANK SUPPORT AND FILL VALVE

WARNING

PNEUMATIC FLOW TESTER G3104 AND COMPONENTS ADAPTER SET 9016796 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

18-1. SCOPE. This section contains start tank support and fill valve preinstallation test requirements. Repair information is not included, since the start tank support and fill valve is not field repairable.

18-2. PREINSTALLATION TESTING.

18-3. The preinstallation test consists of a reverse leakage and a flow test of the ground fill inlet and refill inlet check valves.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following test equipment and materials, or their equivalents. Items 2 and 5 through 8 are in components adapter kit 9016796.

(1) Pneumatic test chamber 61312.

(2) Tank support and fill valve adapter set 9022529.

(3) Gaseous helium source, pressurized to a minimum of 550 psig. Helium must conform to pressurizing and purging requirements for helium in R-3825-3, Volume I.

(4) Pneumatic Flow Tester G3104.

(5) Union AN815-8C (2 required) or reducer AN919 (2 required) of appropriate size to adapt 1/2 inch threaded ports of tank support and fill valve adapter set to pressurized helium source.

(6) Packing MS28778-8 (2 required) to seal unions or reducers (refer to item 5).

(7) Union AN815-4C or reducer AN919 of appropriate size to adapt 1/4 inch threaded port of tank support and fill valve adapter set to pressurized helium source.

(8) Packing MS28778-4 to seal union or reducer (refer to item 7).

NOTE

When this procedure requires a pressure to be applied, the pressurization rate must not exceed 400 psig per second.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Install valve into test adapter (figure 18-1). Seal adapters to ground fill inlet and refill inlet ports by tightening adapters until metal-to-metal contact is obtained.

d. Install unions or reducers as required to adapt threaded ports of adapter set to pressurized helium source. Lubricate (Method J, R-3825-3, Volume I) packings and lubricate (Method A, R-3825-3, Volume I) threads of unions or reducers, as applicable, with lubricant grease RB0140-012 (Rocketdyne). Torque 1/2 inch fittings to 180-230 in-lb and 1/4 inch fitting to 55-80 in-lb.

e. Make sure instrumentation port TF1 is sealed with a pressure-type plug.

NOTE

Ports A, B, and C referenced in the remainder of this procedure are identified in figure 18-1.

f. Apply 500 ±20 psig to port C for 2 (+1, -0) minutes; then measure leakage from port A and from port B. Leakage must not exceed 2 scim from port A and 3 scim from port B.

g. Remove pressure from port C and with port B blocked and port C open, slowly apply pressure to port A until a minimum of 5 scfm is flowing from port C. Pressure at port A must not exceed 30 psig.

h. With ports B and C open and port A blocked, slowly apply pressure to port B until a minimum of 5 scfm is flowing from port C. Pressure at port B must not exceed 30 psig.

i. Secure test equipment and disassemble test setup.

j. Repackage start tank support and fill valve and attach condition tag.

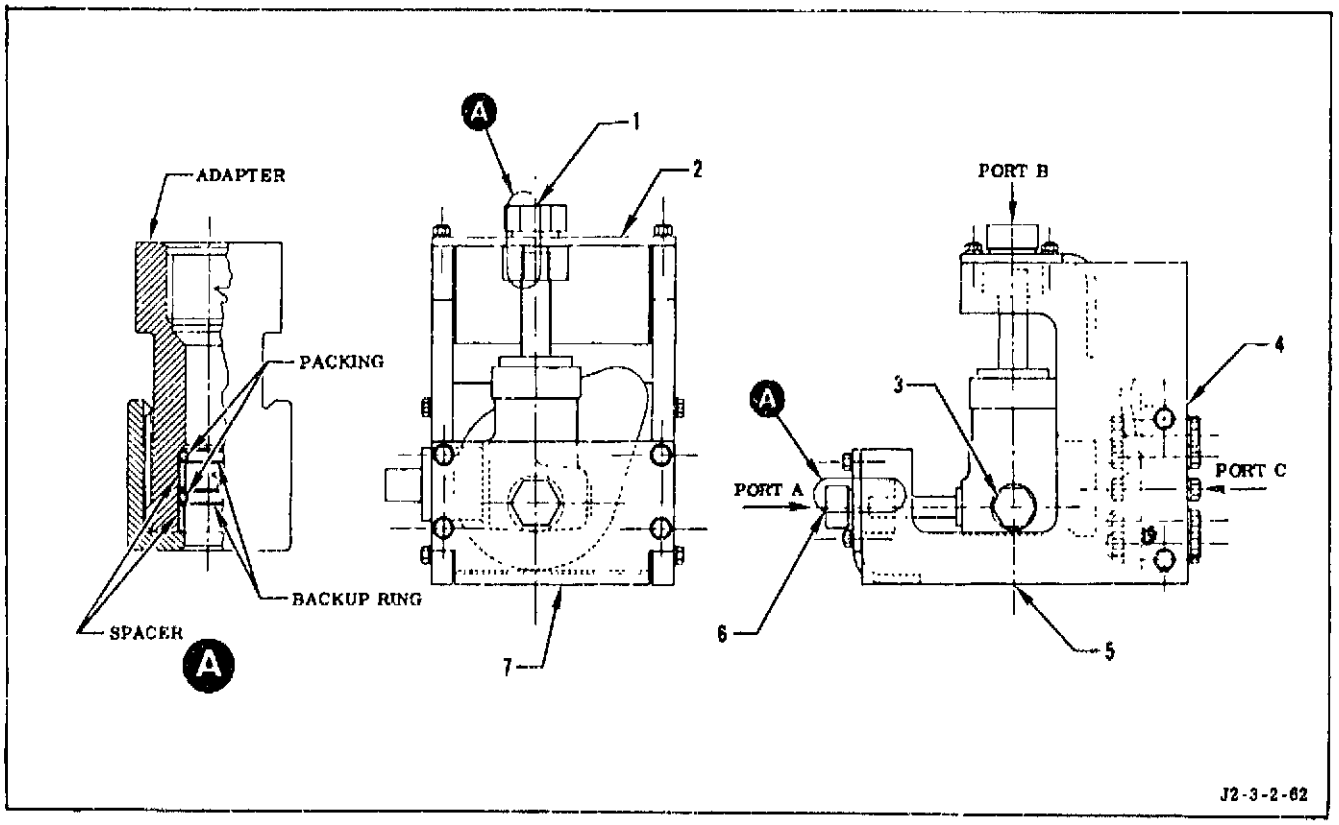


Figure 18-1. GSE Setup for Start Tank Support and Fill Valve (Sheet 1 of 2)

Index No.	Description	Quantity Required
1	9020045-81 Adapter	1
	9022424-3 Spacer	2
	MS28782-16 Backup Ring	2
	AN6227-16 Packing	2
2	9022580 Retainer	1
	NAS1004-3A Bolt (Torque to 68-82 in-lb.)	4
	RD153-5004-0004 Washer	4
3	701852 Plug	1
	404659 Seal (Torque to 40-55 in-lb.)	1
4	9022568 Plate	1
	RD261-3014-0042 Seal	1
	NAS1006-29A Bolt (Torque to 252-308 in-lb.)	12
	NAS679C6W Nut	12
	MS15795-814 Washer	12
5	9022569 Brace	2
	NAS1004-9A Bolt (Torque to 68-82 in-lb.)	4
	RD153-5004-0004 Washer	4
6	9020045-71 Adapter	1
	9022424-5 Spacer	2
	MS28782-11 Backup Ring	2
	AN6227-11 Packing	2
7	9062557 Retainer	1
	NAS1004-3A Bolt (Torque to 68-82 in-lb.)	4
	RD153-5004-0004 Washer	4

Figure 18-1. GSE Setup for Start Tank Support and Fill Valve (Sheet 2 of 2)

SECTION XIX

THRUST CHAMBER

19-1. SCOPE. This section contains thrust chamber repair information only. Post-repair test requirements are provided by Rocketdyne Representative on an individual basis based on the type and extent of the repair made.

19-2. REPAIRING.

19-3. Figure 19-1 lists type and disposition for typical thrust chamber damage. Rocketdyne Representative will provide disposition for damage outside the scope of figure 19-1.

Damage	Limit	Disposition
Tube scratches (internal and external)	Metal removal 0.001 inch or less deep by 0.010 inch wide.	Acceptable.
	Metal removal between 0.001 and 0.005 inch deep.	Torch-braze (paragraph 19-8).
	Metal removal greater than 0.005 inch deep.	Notify Rocketdyne Representative.
	Metal removal greater than 0.010 inch wide.	Notify Rocketdyne Representative.
Tube dents	Metal removed from a dent.	Acceptable to limits specified for tube scratches.
	A maximum of 50 dents, 0.020 inch or less deep, located within combustion zone and including the area 6 inches aft of the throat.	Acceptable.
	Dents greater than 0.020 inch deep, located within combustion zone, and including area 6 inches aft of throat.	Notify Rocketdyne Representative.
	A maximum of 350 dents, 0.060 inch or less deep, inside chamber (but outside of combustion zone including area 6 inches aft of throat) and all exterior areas of chamber.	Acceptable.

Figure 19-1. Thrust Chamber Damage Limits (Sheet 1 of 3)

Damage	Limit	Disposition
Tube dents (continued)	Dents greater than 0.060 inch deep, all inside or outside chamber areas.	Notify Rocketdyne Representative.
Tube discoloration	Dark spots or streaks on tubes with no metal removal.	Acceptable.
Tube erosion	Strong evidence of metal removal.	Notify Rocketdyne Representative.
Tube cracks	Transverse cracks in combustion zone.	Acceptable.
	External transverse cracks in tubes.	Notify Rocketdyne Representative.
Tube splits	Longitudinal splits in the combustion zone.	Notify Rocketdyne Representative.
Tube pinholes	Holes 0.030 inch or less in diameter, void of braze.	Repair (paragraph 19-9).
	Holes 0.030 inch or less in diameter, contaminated with braze.	Repair (paragraph 19-8).
	Holes greater than 0.030 inch in diameter or obstructed by bands.	Notify Rocketdyne Representative.
Braze cracks or voids	Cracks in braze joints or apparent lack of braze between tubes.	Acceptable if joint does not leak. If joint leaks, torch braze (paragraph 19-7).
Turbine exhaust manifold cracks	Cracks in vertical and horizontal drain bosses.	Repair (paragraph 19-11).
	Cracks in start tank discharge valve drain boss.	Repair (paragraph 19-11).
Weld or parent metal cracks		Notify Rocketdyne Representative.
Turbine exhaust manifold dents	Dents 0.25 inch or less deep with a one-inch minimum radius.	Acceptable.
	Dents greater than 0.25 inch deep.	Notify Rocketdyne Representative.

Figure 19-1. Thrust Chamber Damage Limits (Sheet 2 of 3)

Damage	Limit	Disposition
Stud damage	Damaged or broken studs in throat ring or bands.	Notify Rocketdyne Representative.
Flange nicks	Nicks in sealing surfaces of flanges that could affect sealing.	Notify Rocketdyne Representative.
Chamber leaks	Tube-to-tube leaks in combustion zone.	Notify Rocketdyne Representative.
	Tube-to-tube leaks in areas other than in the combustion zone.	Torch-braze (paragraph 19-7) from inside of chamber.
	Tube-to-exit ring leaks and inserts at aft end of fuel manifold leaks.	Notify Rocketdyne Representative.
	Tube-to-fuel ring leaks and inserts to turbine exhaust ring leaks.	Notify Rocketdyne Representative.
Insulation damage	Damaged silicone elastomer insulation and polyurethane insulation.	Refer to section X for insulation damage limits and repair procedures.

Figure 19-1. Thrust Chamber Damage Limits (Sheet 3 of 3)

19-4. CLEANING BEFORE REPAIRING TUBES.

a. Obtain the following equipment and materials , or their equivalents:

(1) Flux mixture of 50 percent B-1 Black Flux and 50 percent Handy White Flux (Handy and Harman).

(2) Fine, stainless steel, wire brush, 0.005 inch maximum wire diameter.

(3) Distilled or deionized water. (Required only if tubes are oxidized or extremely dirty.)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Clean all joints and tube surfaces to be repaired by vigorously hand-brushing with stainless steel wire brush and flux mixture.

d. If area was oxidized or extremely dirty, wash out flux with distilled or deionized water and check area for cleanness. Reclean as necessary.

19-5. CLEANING BEFORE REPAINTING.

a. Obtain the following equipment and materials, or their equivalents:

(1) Fine, stainless steel, wire brush, 0.005 inch maximum wire diameter.

(2) Abrasive paper, No. 320 or 400 grit.

(3) Naphtha (Federal Specification TT-N-95) or drycleaning solvent (Federal Specification P-D-680, Type I).

(4) Sinclair Strip Kleen No. 171 (Sinclair Paint Co). Required only if existing paint is to be removed.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. If painted surface is extremely damaged, use paint remover and remove paint.

d. Using stainless steel wire brush, hand-brush loose paint from area to be repaired.

e. Blend rough edges with abrasive paper.

WARNING

The following procedure specifies naphtha or drycleaning solvent which are flammable and must not be used near heat, sparks, or open flame. Inhalation of their vapors or prolonged contact with the liquid can cause serious injury.

f. Clean area by wiping with a clean cloth dampened in naphtha (TT-N-95) or drycleaning solvent (P-D-680, Type I).

19-6. CLEANING CONTAMINATED PAINTED SURFACES.

WARNING

The following procedure specifies drycleaning solvent which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

a. Obtain drycleaning solvent (P-D-680, Type I) and clean cloths.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I

c. Clean contaminated painted surfaces with clean cloth moistened with solvent.

19-7. TORCH BRAZING FOR TUBE-TO-TUBE REPAIRS. To minimize problems presented by reinforcing bonds, components, fittings, wiring, etc on the outside of the thrust chamber, it is preferable, whenever possible, to do the repair on the inside diameter of the thrust chamber.

a. Obtain the following equipment and materials, or their equivalents:

(1) Bristle brush.

(2) Gold-nickel brazing alloy RB0170-064 (Rocketdyne).

(3) Flux mixture of 50 percent B-1 Black Flux and 50 percent Handy White Flux (Handy and Harman).

(4) Conventional oxyacetylene welding set with torch equipped with size 0 or smaller tip.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Clean all joints to be brazed in accordance with paragraph 19-4.

d. Protect wiring, instrumentation, etc against the 500° F, maximum, heat encountered during brazing.

e. Using bristle brush, apply thin coat of flux mixture to area to be brazed.

f. Using oxyacetylene torch, apply a soft, neutral, or slightly reducing flame to 2 tubes forming joint to be brazed. Confine flame to joint to be brazed by holding tip of flame cone in joint groove.

CAUTION

Braze buildup that exceeds the crown of adjacent tubes can result in local hot spots during engine operation.

g. Start at one end of joint and apply small amount of brazing alloy to heated area, flowing alloy along joint and adding additional alloy as necessary. Braze repair to a height equal to surrounding existing braze. Braze buildup must not exceed crown of adjacent tubes. Do not braze over or remove any of the existing alloy. If it is necessary to braze over or remove existing alloy, notify Rocketdyne Representative.

19-8. TORCH BRAZING FOR FILLING DENTS AND SCRATCHES, AND REINFORCEMENT.

a. Obtain the following equipment and materials, or their equivalents:

(1) Flux mixture of 50 percent B-1 Black Flux and 50 percent Handy White Flux (Handy and Harman).

(2) Conventional oxyacetylene welding set with torch equipped with size 0 or smaller tip.

(3) Gold-silver-copper-zinc brazing alloy RB0170-089 (Rocketdyne).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Clean all dented areas to be filled in accordance with paragraph 19-4.

d. Protect wiring, instrumentation, etc against the 500° F, maximum, heat encountered during brazing.

e. Apply enough flux mixture to prevent oxidation, to area to be brazed.

f. Using oxyacetylene torch adjusted to produce a neutral or slightly reducing flame, apply brazing alloy to rebuild scratched or dented area to original tube contour.

19-9. TUNGSTEN-INERT-GAS-WELDING FOR PINHOLE REPAIRS.

a. Obtain a heliarc welder and CRES 347 filler rod or wire (MIL-R-5031, Class 5A), 0.045 inch diameter.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Clean all dented areas to be repaired in accordance with paragraph 19-4.

d. Protect wiring, instrumentation, etc against the 500° F, maximum, heat encountered during welding.

e. Tungsten-inert-gas-weld with filler rod or wire.

19-10. TOUCHING UP PAINTED SURFACES.

a. Obtain the following equipment and materials, or their equivalents. (Items 4 through 6 are not required unless repair coatings are to be sprayed.)

(1) Masking tape, paper, plugs and other suitable material to protect surfaces that are not to be coated.

(2) Yellow zinc chromate primer (MIL-P-8585).

(3) Passive temperature-control coating RB0125-001 (Rocketdyne).

(4) Xylene (Federal Specification TT-X-916).

(5) No. 2 Zahn viscosimeter.

(6) Conventional air-spray equipment or No. 50 aerosol power unit spray gun (W. P. Fuller Paint Co).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Clean area to be repainted as outlined in paragraph 19-5.

d. Cover adjacent surfaces not to be coated, with masking paper, tape, plugs, or other suitable materials.

WARNING

The following procedure specifies primer (MIL-P-8585), which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

e. Apply one coat of primer to areas to be coated.

f. If coating is to be applied by spray, mix 3 parts by volume of passive temperature-control coating with one part by volume of xylene. Before use, test viscosity of mixture, using a No. 2 Zahn viscosimeter. Viscosity must be 16-20 seconds. If viscosity exceeds 20 seconds, add more xylene until viscosity is within required range. If viscosity is less than 16 seconds, add more coating.

g. Brush or spray one full coat of coating material or mixture over the zinc chromate primer. If sprayed, maintain a traversing rate that gives a wet coat without feathering, sagging, or running.

h. Allow first coat to air dry for 15 minutes, minimum.

i. Apply second coat in cross direction to first coat until surface beneath is completely covered, using same equipment and traversing rate used for first coat.

j. Allow second coat to air dry for 48 hours, minimum.

19-11. REPAIRING CRACKS IN TURBINE EXHAUST MANIFOLD VERTICAL AND HORIZONTAL DRAIN BOSSES 204355-79 AND 204355-83, AND START TANK DISCHARGE VALVE DRAIN BOSS 206603. Cracks in the turbine exhaust manifold vertical and horizontal drain bosses, start tank discharge valve drain boss, or parent manifold material adjacent to the drain boss welds can be repaired as follows:

a. Obtain the following equipment and materials, or their equivalents:

(1) Fine, stainless steel, wire brush, 0.005 inch maximum wire diameter.

(2) CRES 347 filler rod or wire (MIL-R-5031, Class 5A), 0.045 inch diameter.

(3) Heliarc welder.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Clean area by handbrushing around crack with stainless steel wire brush.

d. Perform a Class II weld using filler rod or wire and a heliarc welder.

e. Dye-penetrant inspect. (Refer to R-3825-3, Volume I.)

19-12. APPLYING ECCOBOND SOLDER UNDER THRUST CHAMBER JACKET TEMPERATURE TRANSDUCER CS1 AND CS1a MOUNTING PADS.

a. Obtain the following equipment and materials, or their equivalents:

(1) Eccobond solder No. 56C (Emerson and Cummings).

(2) Catalyst No. 9 (Emerson and Cummings).

(3) Toluene (MIL-T-19588).

(4) Duxseal waterproof compound (Johns-Manville Products).

(5) Syringe (3 milliliter).

(6) No. 17 hypodermic needle.

(7) Eyedropper.

(8) Heat-sink compound DC340 (Dow Corning Corp).

(9) Trichloroethylene (MIL-T-27602), cleaning compound (MIL-C-81302), or trichloroethane (MIL-T-81533).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume 1.

c. Without disconnecting electrical connector P129 or P130, remove thrust chamber jacket temperature transducer CS1 or CS1a as follows: (See figure 19-2.)

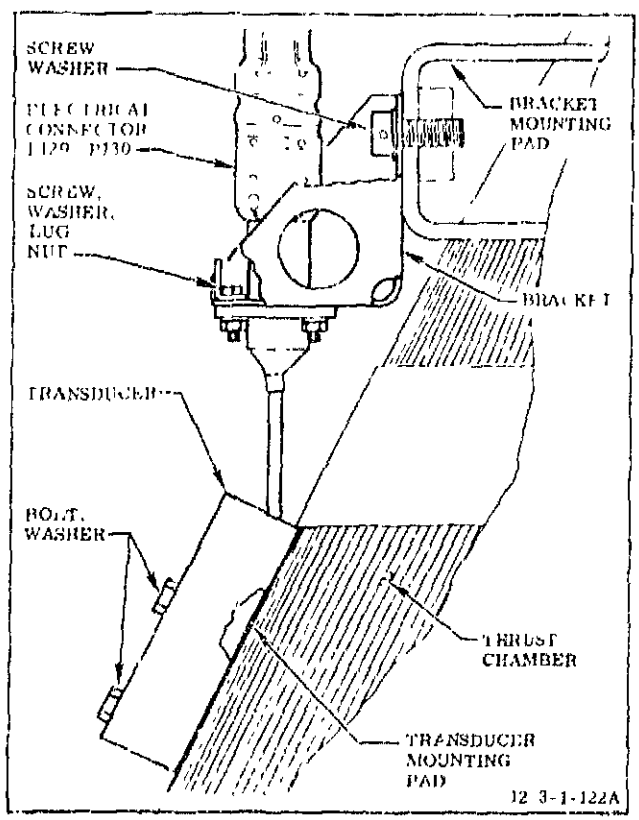


Figure 19-2. Thrust Chamber Jacket Temperature Transducers

(1) Remove bolts and washers that secure temperature transducer to transducer mounting pad.

(2) Remove screws and washers that secure bracket to bracket mounting pad on thrust chamber.

(3) Move transducer away from mounting pads.

WARNING

The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

(4) Remove heat-sink compound from transducer and transducer mounting pad. Clean transducer and transducer mounting pad by wiping with clean, lint-free cloth dampened with trichloroethylene, cleaning compound, or trichloroethane.

d. To determine if passages between transducer mounting pad and thrust chamber tubes are open, insert a piece of Inconel lockwire (MS20995N20) into each passage. Insert lockwire from the lower end of transducer mounting pad and push lockwire up through passage to opposite end of pad. If any passage is obstructed, mark its position.

WARNING

The following procedure specifies solder Eccobond 56C, which may irritate skin. Protective clothing must be worn when handling solder. In case of contact, wash skin with soap and water.

e. Prepare Eccobond solder as follows:

(1) Weight 100 grams of Eccobond solder, 5 grams of catalyst, and 5 grams of toluene.

(2) Place materials in a clean glass or metal container. Mix materials thoroughly until smooth and mixture has the consistency of syrup. To obtain desired consistency additional toluene (up to 15 additional grams) is allowed. Make sure mixture is smooth, since small lumps will plug hypodermic needle. (Pot life of mixture is 1.5 to 2.0 hours.)

f. Fill syringe with Eccobond solder mixture. Insert hypodermic needle (at lower end of transducer mounting pad) in passage between transducer mounting pad and thrust chamber tubes. Pack Duxseal waterproof compound around hypodermic needle. Do not plug adjacent passages.

g. Inject mixture into passage until mixture can be seen at upper end of transducer mounting pad. (Mixture will not be seen if passage is obstructed).

h. Immediately press down on Duxseal waterproof compound to seal lower end of passage when hypodermic needle is removed.

i. For passages that are obstructed and Eccobond solder cannot be seen at upper end of transducer mounting pad, insert hypodermic needle into passage from upper end of transducer mounting pad and inject mixture into passage until mixture is even with top of the pad.

j. Allow solder mixture to cure (12 hours) at ambient temperature. Applying heat (heat gun or lamp) will shorten curing time to 30 minutes (160° F) or 15 minutes (250° F).

k. Remove Duxseal waterproof compound from end of mounting pad after Eccobond solder mixture has cured.

l. Install thrust chamber jacket temperature transducer CS1 or CS1a as follows:

NOTE

There must not be cavities in the compound that could cause air pockets between the transducer and the transducer mounting pad.

(1) Spread an even coat of heat-sink compound DC340 (Dow Corning Corp) in recessed area of transducer so that recessed area is filled from flush to 1/16 inch above mating surface of transducer.

(2) Position and secure transducer to transducer mounting pad with bolts and washers; lubricate (Method A, R-3825-3, Volume I) bolts with lubricant grease RB0140-012 (Rocketdyne). Do not tighten bolts.

(3) Secure bracket to bracket mounting pad with screws and washers. Torque screws to 67-92 in-lb.

(4) Torque bolts securing transducer to transducer mounting pad to 3-5 in-lb and safetywire.

SECTION XX

TRANSDUCERS

20-1. SCOPE. This section contains preinstallation test requirements for speed, flow, pressure, temperature, and position transducers. Repair information is not included, since transducers are not field repairable.

20-2. PREINSTALLATION TESTING FUEL TURBOPUMP SPEED TRANSDUCER NA5-27328 AND FUEL AND OXIDIZER FLOW TRANSDUCERS NA5-27331.

20-3. The preinstallation test of speed and flow transducers consists of measuring the coils resistances, coil-to-coil resistance, and case-to-coils resistances.

a. Obtain the following test equipment, or their equivalents.

(1) Ohmmeter, Model 630 (Triplett) or Model 260 (Simpson).

(2) Megohmmeter, Model 1620C (Freed Transformer Co).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Measure resistance between pin A or B and case and between pin C or D and case. With 50 vdc applied, resistance must be greater than 50 megohms.

d. Measure resistance between pins A and C. With 50 vdc applied, resistance must be greater than 5 megohms.

e. Measure resistance between pins A and B. Resistance must be 1,270 ±500 ohms except on transducer NA5-27328, resistance must be 250 ±50 ohms.

f. Measure resistance between pins C and D. Resistance must be 1,270 ±500 ohms except on transducer NA5-27328, resistance must be 300 ±60 ohms.

g. Secure test equipment and disassemble test setup.

h. Repackage transducer and attach condition tag.

20-4. PREINSTALLATION TESTING PRESSURE TRANSDUCERS NA5-27412 AND NA5-27440.

20-5. The preinstallation test of pressure transducers consists of measuring ambient and simulated 20 and 80 percent outputs of the transducer.

a. Obtain the following test equipment, or their equivalents.

(1) A 28-vdc power supply. The power supply output ripple must be less than 0.1 volt peak, and transients less than 50 volts peak with 10-microseconds width and no more than 20 pulses per second.

(2) Digital voltmeter, capable of reading to 0.0001 volt.

(3) Test leads and pin connectors as necessary to interconnect transducer, power supply, and digital voltmeter.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Perform this test with the transducer pressure port exposed to an ambient pressure of 14.7 ±1 psia.

d. Connect transducer pins B (+) and C (-) to digital voltmeter.

e. Apply 28 ±0.1 vdc to transducer pins A (+) and D (-) and measure transducer output on digital voltmeter. Voltage output must be within ambient output voltage range shown in figure 20-1 for transducer being tested.

Transducer Range Psia	Ambient Output (vdc)	20% Output (vdc)	80% Output (vdc)
0-50	1.300 to 1.700	2.300 to 2.700	--- ---
0-100	0.550 to 0.950	1.550 to 1.950	4.550 to 4.950
0-200	0.175 to 0.575	1.175 to 1.575	4.175 to 4.575
0-500	-0.050 to +0.350	0.950 to 1.350	3.950 to 4.350
0-750	-0.100 to +0.300	0.900 to 1.300	3.900 to 4.300
0-1,000	-0.125 to +0.275	0.875 to 1.275	3.875 to 4.275
0-1,500	-0.150 to +0.250	0.850 to 1.250	3.850 to 4.250
0-2,000	-0.163 to +0.237	0.837 to 1.237	3.837 to 4.237
0-3,000	-0.178 to +0.222	0.822 to 1.222	3.822 to 4.222
0-5,000	-0.185 to +0.215	0.815 to 1.215	3.815 to 4.215

Figure 20-1. Pressure Transducer Output Voltage Requirements

f Apply +28 ±0.1 vdc power to transducer pin E. Do not remove test lead from transducer pin A (+28 ±0.1 vdc is to be applied to both transducer pins A and E for this step). Measure transducer output on digital voltmeter. Voltage output must be within 20 percent voltage range shown in figure 20-1 for transducer being tested.

g. Remove +28 vdc test lead from transducer pin E and connect lead to transducer pin F (+28 ±0.1 vdc is to be applied to both transducer pins A and F for this step). Measure transducer output on digital voltmeter. Voltage output must be within 80 percent voltage range shown in figure 20-1 for transducer being tested.

h Secure test equipment and disassemble test setup.

i. Repackage transducer and attach condition tag.

20-6. PREINSTALLATION TESTING TEMPERATURE TRANSDUCERS NA5-27215T3, T5, AND T7; NA5-27321T2; NA5-27323T3 AND T6; NA5-27325T1; NA5-27326; AND NA5-27441.

20-7. The preinstallation test of temperature transducers consists of measuring internal resistance.

a. Obtain the following test equipment, or their equivalents.

(1) Null-type resistance measuring device or a digital voltohmmeter. Equipment must be current limiting to one-milliampere maximum.

(2) Pin connectors and test leads to interconnect milliohmmeter and transducer electrical pins.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Perform this test with the transducer at an ambient temperature of 38° to 110° F.

CAUTION

Use of ohmmeter other than specified in step a can result in inducing currents that will either damage the transducer or result in erroneous resistance readings.

d. Using milliohmmeter, measure resistance between pins A and B and A and C. Resistance must be within range shown in figure 20-2 for transducer being tested.

Transducer	Resistance (ohms)
NA5-27215T3	1,270-1,470
NA5-27215T5	1,270-1,470
NA5-27215T7	432-498
NA5-27321T2	1,270-1,470
NA5-27323T3	50-60
NA5-27323T6	50-60
NA5-27325T1	1,270-1,470
NA5-27326	1,270-1,470
NA5-27441	1,270-1,470

Figure 20-2. Temperature Transducer Resistance Requirements

e. On dual-element transducers (dual-element transducers incorporate a 6-pin electrical connector), measure resistance between pins D and E and D and F. Resistance must be within range shown in figure 20-2 for transducer being tested.

f. Secure test equipment and disassemble test setup.

g. Repackage transducer and attach condition tag.

20-8. PREINSTALLATION TESTING POSITION TRANSDUCERS 405817, 408012, NA5-27306, NA5-27307, AND NA5-27480.

20-9. The preinstallation test of position transducers consist of pin-to-case resistance tests (megohmmeter test), pin-to-pin resistance tests, and operating force tests.

a. Obtain the following test equipment, or their equivalents.

(1) Model 630 multimeter (Triplett). An equivalent must meet only resistance measuring capability.

(2) Model 1862C megohmmeter (General Radio).

(3) Pin connectors and test leads to interconnect multimeter or megohmmeter to transducer.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Perform this test at an ambient temperature of 59° to 95° F.

d. Perform a megohmmeter test at 50 vdc on all pins (except pin G) to case. Allow megohmmeter to stabilize (up to one minute) before reading resistance value. Resistance must be a minimum of 100 megohms from each pin to case.

e. Measure resistance between pins A and C. Resistance must be 2,000 ±100 ohms.

f. Move transducer shaft slowly in direction that maximizes resistance reading between pins A and B. Resistance must increase smoothly in direct relation to shaft movement, and force necessary to move shaft must be smooth without binding. A force change may be felt when position switches make or break. GG valve potentiometer NA5-27307 may require 25 pound force for actuation.

g. Move transducer shaft fully in direction that will cause continuity to be indicated between pins E and F; then measure resistance between pins E and F. Resistance must not exceed 1.5 ohms.

h. With transducer positioned as required by step g, perform a megohmmeter test at 50 vdc between pins D and E. Allow megohmmeter to stabilize (up to one minute) before reading resistance value. Resistance must be a minimum of 10 megohms.

i. Move transducer shaft fully in direction that will cause continuity to be indicated between pins D and E; then measure resistance between pins D and E. Resistance must not exceed 1.5 ohms.

j. With transducer positioned as required by step i, perform a megohmmeter test at 50 vdc between pins E and F. Allow megohmmeter to stabilize (up to one minute) before reading resistance value. Resistance must be a minimum of 10 megohms.

k. Deenergize megohmmeter, move transducer shaft to approximately mid-position and verify continuity lost between pins D and E and E and F.

l. With transducer positioned as required by step k, perform a megohmmeter test at 50 vdc between pins D and F. Allow megohmmeter to stabilize (up to one minute) before reading resistance value. Resistance must be a minimum of 10 megohms.

m. Secure test equipment and disassemble test setup.

n. Repackage transducer and attach condition tag.

SECTION XXI

VENT PORT CHECK VALVES

WARNING

PNEUMATIC FLOW TESTER G3104 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

21-1. SCOPE. This section contains vent port check valve preinstallation test, low-temperature test, and drying requirements. Repair information is not included since vent port check valves are not field repairable.

21-2. PREINSTALLATION TESTING

21-3. Preinstallation test of the vent port check valve consists of verifying that the valve has opened when a maximum acceptable pressure is applied and that forward and reverse flow leakage rates are acceptable.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following test equipment and materials, or their equivalents.

(1) Pneumatic test chamber 61312.

(2) Plug and body fixtures, packings, and fittings as required for valve to be tested (see figure 21-1).

(3) Pneumatic Flow Tester G3104.

(4) Gaseous nitrogen source, pressurized to a minimum of 10 psig. Nitrogen must conform to pressurizing and purging requirements for nitrogen in R-3825-3, Volume I.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Manually unseat valve poppet. Check valve 553364-21 poppet may be unseated by depressing underside of poppet with a suitable clean plastic or metal probe.

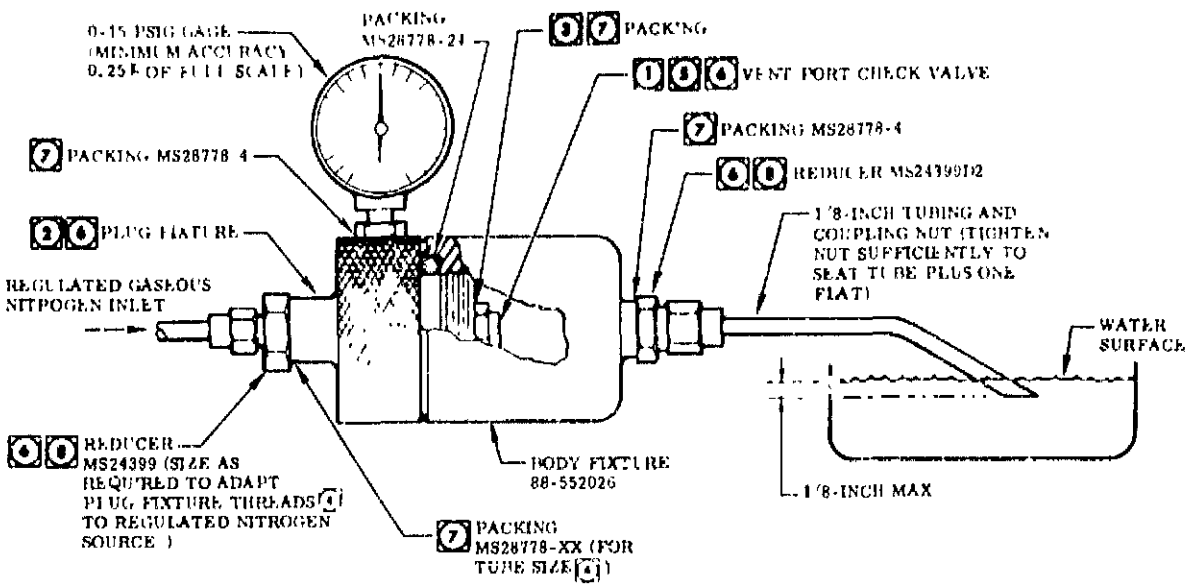
d. Install vent port check valve in test setup (see figure 21-1), except do not immerse 1/8-inch tube in water.

e. On all check valves except 553364-21 and 553373-11, apply a maximum of 3.75 psig pressure to inlet port and verify flow from outlet port. On valves 553364-21 and 553373-11, apply a maximum pressure of 4.5 psig and 2.75 psig respectively to inlet port and verify flow from outlet port.

f. Apply 0.50 ±0.05 psig pressure to inlet port and, with end of 1/8 inch tube immersed in water (see figure 21-1), monitor end of tube for a minimum of 3 minutes. There must be no leakage as evidenced by formation of bubbles.

g. Remove 1/8 inch tube from water and increase pressure to inlet port until visual or audible flow is obtained through test setup. Maintain flow for a minimum of 3 minutes to ensure removal of moisture that may have migrated into body fixture.

h. Change test setup to apply regulated pressure source to outlet port and connect flowmeter to inlet port.



1	2	3	4	5 TORQUE TO
553364-21	88-552028	MS28778-4	1/4-INCH	40-65 IN-LB
553372-11	88-552028	MS28778-4	1/4-INCH	40-65 IN-LB
553373-11	88-552029	MS28778-6	1/2-INCH	80-100 IN-LB
553375-11, -21	88-552031	MS28778-12	3/4 INCH	175-200 IN-LB
557809-11, -21, 31	88-552031	MS28778-12	3/4-INCH	175-200 IN-LB

6 LUBRICATE (METHOD A, R-3825-3, VOLUME I) THREADS WITH LUBRICANT GREASE RB0140-012 (ROCKETDYNE).

7 LUBRICATE (METHOD J, R-3825-3, VOLUME I) PACKING WITH LUBRICANT GREASE RB0140-012 (ROCKETDYNE).

8 TORQUE 1/4-INCH (TUBE SIZE) FITTINGS TO 55-80 IN-LB.
TORQUE 3/8-INCH (TUBE SIZE) FITTINGS TO 100-150 IN-LB.
TORQUE 3/4-INCH (TUBE SIZE) FITTINGS TO 420-600 IN-LB.

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Figure 21-1. Vent Port Check Valve Preinstallation Test Setup

i. Apply 1 ±0.1 psig pressure to outlet port and measure leakage from inlet port. Leakage must not exceed one scim.

j. Secure test equipment and remove valve from test fixture.

k. Repackage vent port check valve and attach condition tag.

21-4. LOW TEMPERATURE TESTING.

21-5. Low temperature testing consists of flowing helium through the valve while the valve is immersed in liquid nitrogen, and verifying that the inlet pressure does not exceed an acceptable value.

WARNING

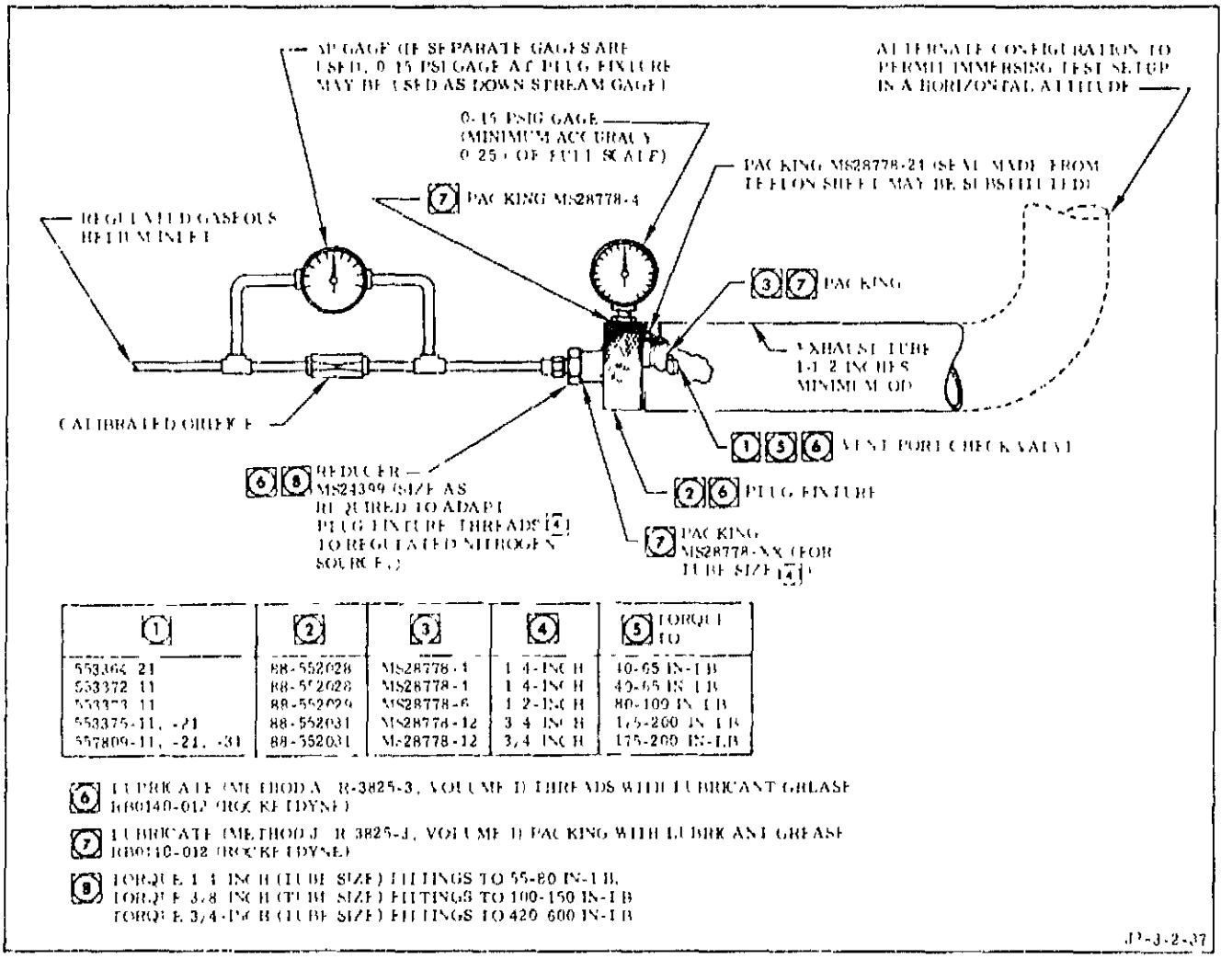
Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following test equipment and materials, or their equivalent.

(1) Orifice calibrated for flow shown in flow column of figure 21-3.

(2) Gage or gages, as required, to read differential pressure across calibrated orifice.

(3) Equipment to assemble test setup shown in figure 21-2.



1	2	3	4	5 TORQUE TO
553364-21	88-552028	MS28778-4	1/4-INCH	40-65 IN-LB
553372-11	88-552028	MS28778-4	1/4-INCH	40-65 IN-LB
553373-11	88-552029	MS28778-6	1/2-INCH	80-100 IN-LB
553375-11, -21	88-552031	MS28778-12	3/4 INCH	175-200 IN-LB
557809-11, -21, -31	88-552031	MS28778-12	3/4 INCH	175-200 IN-LB

6 LUBRICATE (METHOD A, R-3825-3, VOLUME I) THREADS WITH LUBRICANT GREASE (MIL-G-81322 (ROCKEDYNE))

7 LUBRICATE (METHOD J, R-3825-3, VOLUME I) PACKING WITH LUBRICANT GREASE (MIL-G-81322 (ROCKEDYNE))

8 TORQUE 1/4 INCH (TUBE SIZE) FITTINGS TO 55-80 IN-LB.
TORQUE 3/8 INCH (TUBE SIZE) FITTINGS TO 100-150 IN-LB
TORQUE 3/4-INCH (TUBE SIZE) FITTINGS TO 420-600 IN-LB

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Figure 21-2. Vent Port Check Valve Low Temperature Test Setup

(4) Metal container and enough liquid nitrogen to immerse valve.

(5) Gaseous helium source, pressurized to, and with enough volume to maintain required pressure (total of pressure drop across calibrated orifice plus maximum inlet pressure to valve). See maximum inlet pressure column of figure 21-3 for maximum inlet pressure to valve.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

Vent Port Check Valve	Flow (scim)	Maximum Inlet Pressure Psig
553364-21	670 ±20	4.75
553372-11	825 ±82	4.0
553373-11	843 ±84	3.0
553375-11, and -21	1430 ±143	4.0
557809-11, -21, and -31	1430 ±143	4.0

Figure 21-3. Vent Port Check Valve Test Parameters

c. Manually unseat valve poppet. Check valve 553364-21 poppet may be unseated by depressing underside of poppet with a suitable clean plastic or metal probe.

d. Install vent port check valve in test setup as shown in figure 21-2. Fittings used to attach exhaust tube to plug fixture are optional, but must be leak tight.

e. Establish a low flow of helium through vent port check valve. Maintain this flow until changed in step h.

NOTE

Flowing helium through the valve subjects the valve to a positive pressure, which helps prevent moisture from being introduced to the valve.

- Low flow is any flow of gas that can be detected visibly or audibly.

f. Keeping 0-15 psi gage and outlet port out of the liquid, immerse as much of plug and body fixtures as practical in liquid nitrogen.

g. Wait until test setup has reached liquid nitrogen temperature (boiling action coming from test setup components has stopped); then proceed to next step.

h. Adjust flow through vent port check valve to value shown in flow column (figure 21-3) and note pressure on 0-15 psi gage. Pressure must not exceed value shown in maximum inlet pressure column (figure 21-3).

i. Remove test setup from liquid nitrogen. Maintain a purge flow through valve until requirements of next step are met.

NOTE

To help conserve helium, the purge may be reduced to a low flow (refer to step e for definition of low flow) and/or nitrogen may be substituted for helium. If nitrogen is substituted it must conform to pressurizing and purging requirements for nitrogen in R-3825-3, Volume I and the substitution made without moisture being introduced to the valve.

j. When plug fixture is within 20° F of ambient temperature and there is no evidence of frost or condensation on test fixtures, discontinue flow through valve. Parts may be wiped dry.

j. Dry vent port check valve. Refer to paragraph 21-7.

21-6. DRYING.

21-7. Vent port check valves may be dried using procedures outlined in paragraph 21-8 (drying at elevated temperatures) or in paragraph 21-9 (drying at ambient temperatures). Both procedures require reducing the absolute pressure to dry the valve, however to dry the valve without elevating the temperature, requires a lower absolute pressure.

21-8. DRYING AT ELEVATED TEMPERATURES.

a. Obtain the following equipment:

(1) Controlled environment (vacuum oven) capable of providing a minimum temperature of 120° F and an absolute pressure of one inch of mercury.

(2) Temperature measuring device capable of measuring the surface temperature of the vent port check valve cap.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Attach temperature measuring device to valve cap.

d. Place valve in vacuum oven. Make sure valve port is open to oven atmosphere.

e. Increase valve temperature to 120° (+10°, -0°) F as indicated on temperature measuring device; then reduce absolute pressure within oven to one inch of mercury absolute. Maintain temperature and pressure for 30 minutes minimum.

f. Return valve to room ambient temperature and pressure.

g. Repackage vent port check valve and attach condition tag.

21-5. DRYING AT AMBIENT TEMPERATURES.

a. Obtain the following equipment:

(1) Vacuum chamber capable of reducing the absolute pressure to required value for temperature of valve (see figure 21-4).

(2) Temperature measuring device capable of measuring the surface temperature of the vent port check valve cap.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in R-3825-3, Volume I.

c. Attach temperature measuring device to valve cap.

d. Place valve in vacuum chamber.

e. Note temperature of valve and see figure 21-4 to determine absolute pressure required to dry valve.

f. Reduce pressure in vacuum chamber to required value and maintain the reduced pressure for 30 minutes minimum.

g. Return valve to ambient pressure.

h. Repackage vent port check valve and attach condition tag.

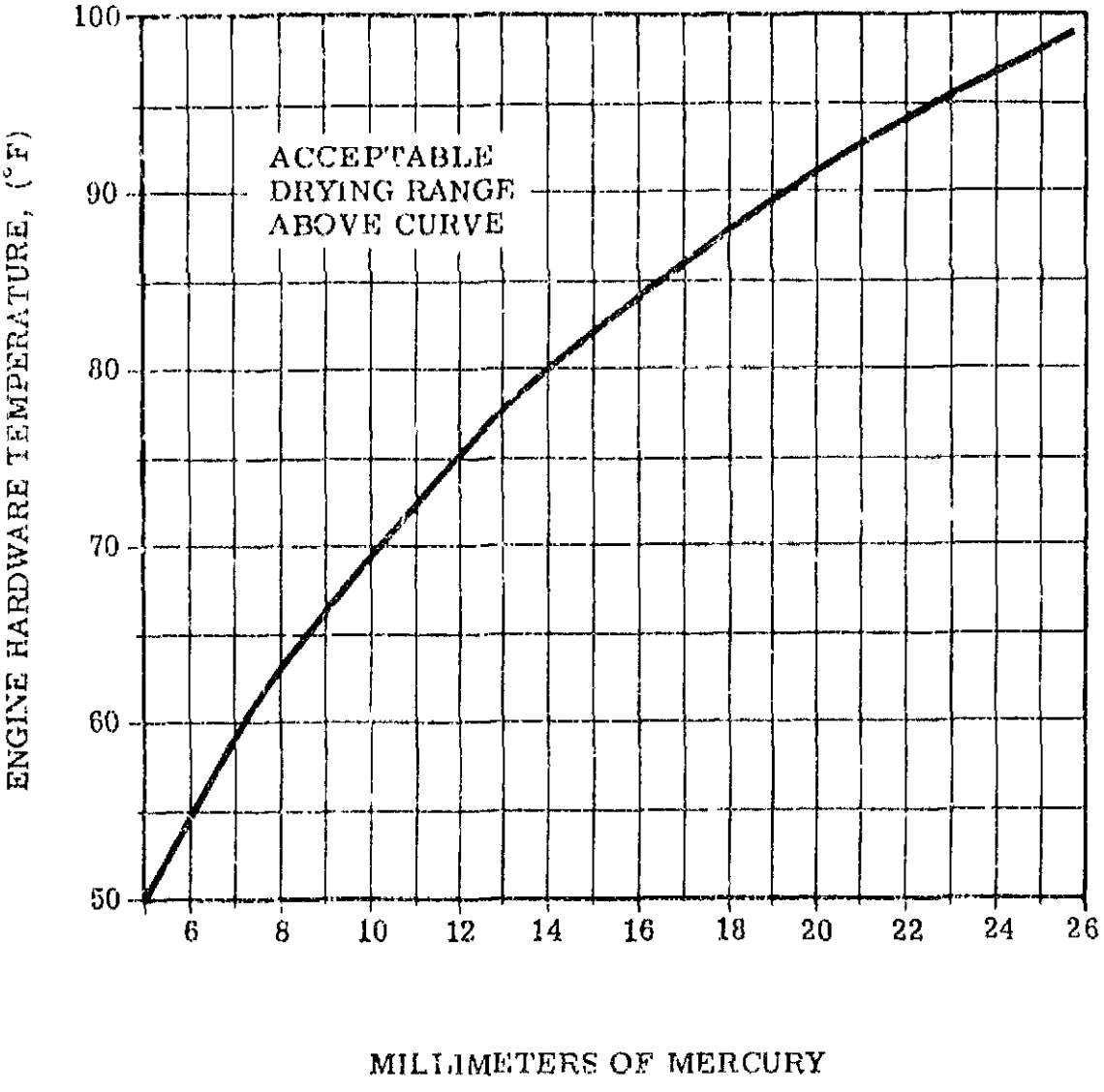

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Figure 21-4. Hardware Temperature Versus Required Absolute Pressure

MANUAL DATA SUPPLEMENTS

Manual Data Supplements are issued from time to time to communicate important and urgent information concerning the equipment covered in this volume. These supplements bear an identifying number and should be filed in this Appendix.

Manual Data Supplements directly affect the data in this volume and will be incorporated into this volume during a future updating effort.

A Supplement Record is issued periodically to indicate the status of supplements issued for this volume. The status of each supplement is indicated in the "Supplement Status" column. For active supplements, no status is entered. For incorporated supplements "Incorporated" is entered.

Upon receipt of a Manual Data Supplement, make an appropriate reference to the supplement in the margin next to the data supplemented and enter the number, date, and subject matter of the supplement in the Manual Data Supplement Record.

MANUAL DATA SUPPLEMENT RECORD

This Manual Data Supplement Record indicates the status of supplements issued for Technical Manual R-3825-3, Volume II. Supplements that have been incorporated into this volume shall be removed from the Appendix and destroyed.

Supplement Number	Dated	Description	Supplement Status
2	18 June 1965	Adds procedure for ignition detector probes.	Incorporated
4	7 September 1965	Adds information on disconnecting, connecting, and protecting electrical connectors.	Incorporated
R-3825-3-7	7 December 1965	Changes maintenance and repair procedures for armored harness.	Incorporated
R-3825-3-13	22 February 1966	Notifies field of problem in using wrench kit 9022284.	Canceled
R-3825-3-14	23 February 1966	Corrects MFV Test Adapter Set installation information.	Incorporated
R-3825-3-18	24 March 1966	Adds oxidizer turbopump turbine requirements.	Incorporated
R-3825-3-26	16 May 1966	Adds inspection requirements and repair procedures for insulation on fuel duct and line, and thrust chamber jacket purge line.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3-27	10 June 1966	Adds instructions for handling, installing and removing pressure-actuated (Naflex) seals.	Incorporated
R-3825-3-29	18 July 1966	Adds inspections for repairing cracks in turbine exhaust manifold drain boss.	Incorporated
R-3825-3-32	17 August 1966	Adds visual and mechanical checks to fuel turbopump procedure to prevent backward installation of first-stage turbine wheel.	Incorporated
R-3825-3 Vol II-1	7 November 1966	Changes torque value of fuel turbopump shaft nut and adds new tool for installation of turbine seal.	Incorporated
R-3825-3 Vol II-2	16 November 1966	Changes thrust chamber damage limits and adds new repair procedure.	Incorporated
R-3825-3 Vol II-3	8 December 1966	Adds new test for start tank discharge valve position.	Incorporated
R-3825-3 Vol II-4	21 December 1966	Changes start tank cover repair requirements and adds new repair procedure.	Incorporated
R-3825-3 Vol II-5	3 January 1967	Changes fuel turbine seal leakage rate.	Incorporated
R-3825-3 Vol II-6	3 January 1967	Adds component insulation repair procedures.	Incorporated
R-3825-3 Vol II-7	18 January 1967	Changes type of dye-penetrant developed.	Incorporated
R-3825-3 Vol II-8	15 February 1967	Adds component insulation procedures.	Incorporated
R-3825-3 Vol II-9	14 February 1967	Changes ignition detector probe part number and adds test procedures.	Incorporated
R-3825-3 Vol II-10	6 September 1967	Adds cleaning procedure for external surfaces of engine and components.	Incorporated
R-3825-3 Vol II-11	20 September 1967	Changes, deletes, and adds page numbers in List Of Effective Pages.	Incorporated
R-3825-3 Vol II-12	16 October 1967	Deletes requirement that turbine end of Fuel Turbopump be disassembled in an environmentally controlled area.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol II-13	23 October 1967	Adds procedural step to verify oxidizer turbopump bearing nut torque is not less than 125 foot-pounds.	Incorporated
R-3825-3 Vol II-14	24 September 1968	Changes standard statement to clarify component repair environmental area requirements.	Incorporated
R-3825-3 Vol II-15	12 March 1969	Adds requirement to protect open ports of components during removal procedures.	Canceled
R-3825-3 Vol II-16	28 February 1969	Changes catalyst and adhesive and method for preparing adhesive for insulation repair.	Incorporated
R-3825-3 Vol II-17	14 October 1969	Adds procedure for applying Eccobond solder under thrust chamber jacket temperature transducer mounting pads.	Canceled
R-3825-3 Vol II-18	20 October 1969	Deletes requirement to replace damaged potting on start tank insulation and adds procedure to repair damaged potting with white sealant.	Incorporated
R-3825-3 Vol II-19	4 November 1969	Changes inspection and repair of armored harnesses and changes callout of sealant to be used for bonding connections.	Incorporated
R-3825-3 Vol II-20	22 October 1969	Adds procedure for applying Eccobond solder under thrust chamber jacket temperature transducer mounting pads.	Incorporated
R-3825-3 Vol II-21	21 January 1970	Cancels supplement R-3825-3 Vol II-15 and refers to R-3825-3, Volume I, section I for information previously contained in supplement.	Incorporated
R-3825-3 Vol II-22	31 March 1970	Adds procedure for leak testing the vent port check valve to determine its acceptability for use.	Incorporated
R-3825-3 Vol II-23	5 October 1970	Adds a procedure for installing Micro-Fibre insulation on replacement components and updates existing repair procedures.	Incorporated
R-3825-3 Vol II-24	3 November 1971	Adds preinstallation test requirements for specific engine components.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol II-25	16 November 1971	Adds testing and repair information on air filler valve (pressurizing valve).	Superseded by Supplement No. R-3825-3 Vol II-27
R-3825-3 Vol II-26	2 December 1971	Adds low-temperature test of vent port check valve 553364.	Incorporated
R-3825-3 Vol II-27	20 December 1971	Adds testing and repair information on air filler valve (pressurizing valve).	Incorporated
R-3825-3 Vol II-28	13 June 1972	Changes limit that pressurized gases are considered low-pressure.	Incorporated
R-3825-3 Vol II-29	24 August 1972	Adds method for conditioning threads of air filler valve core.	Superseded by Supplement No. R-3825-3 Vol II-30
R-3825-3 Vol II-30	2 October 1972	Changes method for conditioning threads of air filler valve core.	Incorporated
R-3825-3 Vol II-31	13 April 1973	Adds warnings for specific materials used in the manual.	Incorporated
R-3825-3 Vol II-32	16 April 1973	Changes leak-test compound (MIL-L-25567) to leak-test compound (MSFC-SPEC-384).	Incorporated
R-3825-3 Vol II-33	14 November 1973	Deletes the dimension of the recessed area in the thrust chamber temperature transducer from the procedure for applying Eccobond solder under thrust chamber jacket temperature CS1 and CS1a mounting pads.	Incorporated
R-3825-3 Vol II-34	8 February 1974	Adds dimensional limits for air filler valve core protrusion.	Incorporated
R-3825-3 Vol II-35	18 March 1974	Adds a procedure for inspecting mainstage OK pressure switches for stress corrosion.	Incorporated